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ARCHIVES OF SURGERY

VOLUME 55 SEPTEMBER 1947 NUMBER 3

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DUODENAL REGURGITATION

ARTHUR R. METZ, M.D.
CHICAGO

DUODENAL regurgitation is a clinical entity which has been recognized for many years, but it has not been given proper consideration by the majority of clinicians and radiologists. The condition may cause prolonged and serious symptoms, which if not recognized and corrected can lead to chronic invalidism, gradual general exhaustion and death.

The term regurgitation would seem more appropriate than duodenal stasis, for it is when the duodenal contents regurgitate into the stomach that the serious symptoms develop.

The most common cause of regurgitation is pressure on the duodenum where it passes over the spine by the mesentery attachment, and this is usually associated with ptosis of the abdominal viscera. Obstruction may also result from the lack of proper rotation of the intestinal tract resulting from a congenital anomaly or from tumor growth or adhesions.

The frequency of occurrence is difficult to determine, for unless the clinician and the radiologist make a careful search, many of the milder cases are overlooked. It has been estimated that about one half of 1 per cent of all routine gastrointestinal examinations in the roentgenology department will show evidence of duodenal regurgitation.

I have had experience with 14 cases in which successful operations were performed and 4 others which contributed much to demonstrate the importance of recognizing this condition.

The ages of the patients in these cases were from 14 to 60. There were 6 males and 8 females, all of whom were of the slender, undernourished type.

The symptoms of duodenal regurgitation vary with the degree of obstruction. When the obstruction is slight, there are recurring attacks of nausea, with disturbed appetite and loss of weight followed by weakness resulting from restricted intake of food.

As the obstruction becomes more advanced the attacks of nausea increase and are followed by a sense of fulness in the right upper area of the abdomen and by vomiting, which come on immediately after the patients start to eat. Some will complain of a definite pain in the right

Presidential address at the fifty-fourth annual meeting of the Western Surgical Association, Memphis, Tenn., Dec. 6, 1946.

upper region of the abdomen, which suggests the presence of disease of the gallbladder, renal ptosis or intestinal obstruction and tends to mask the true condition.

In the progressive case the loss of appetite and the pernicious vomiting result in extreme dehydration, emaciation, gradual exhaustion and death.

The presence of duodenal regurgitation should be suspected when a history is obtained of repeated attacks of nausea and vomiting, which are not explainable by the ordinary causes suggestive of an organic lesion in the abdomen.

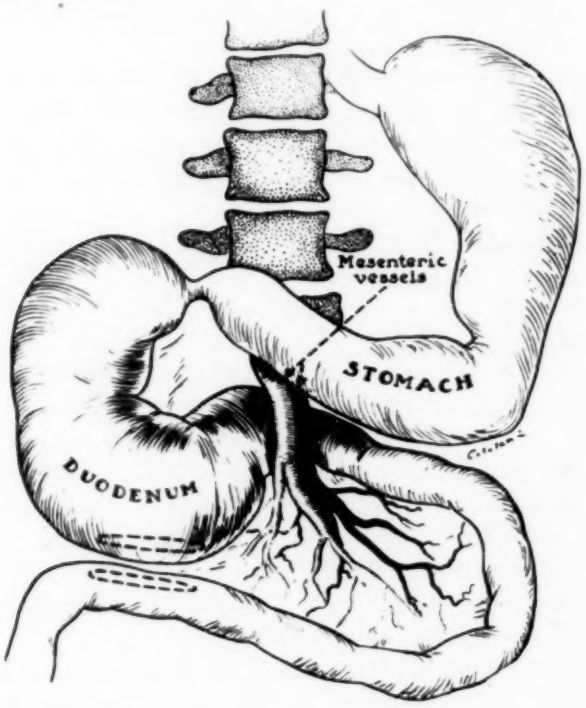

Fig. 1.—Dilated duodenum due to pressure of the mesentery where it passes over the spine.

A positive diagnosis is made by a careful fluoroscopic examination. The stomach is usually large and of the low vertical J-shaped type with a highly placed outlet. The duodenum is dilated to several times its normal size. The barium meal will be observed to stop to the right of the spine and churn back and forth because of hyperperistalsis and then to regurgitate back into the stomach. After a delay of five to ten minutes, the barium may be forced over the spine and may move along in a normal manner. The size of the duodenum will depend on the duration and degree of obstruction.

In the differential diagnosis the condition will have to be distinguished from disease of the gallbladder, cysts or tumors of the duodenum, anomalies producing kinks or bands resulting in obstruction and ptosis of the right kidney.

The treatment depends on the degree of obstruction present. When it is slight and the symptoms come and go, careful medical management consisting in regulation of the intake of food and rest at mealtime may

Fig. 2.—Roentgenogram showing typical dilated duodenum.

give the desired results. The object is to increase the weight of the patient so as to increase the fat in the abdomen with the hope that pressure on the duodenum will be reduced.

When the symptoms of fulness, nausea and vomiting are persistent, the patient should be given rest in bed and frequent small feedings of nourishing foods. Various positions should be tried during and after meals with the hope of relieving pressure and aiding in the passage of

food over the spine. Lying on the left side or on the abdomen may give relief. The knee-chest position may also be tried and in some cases has given good results.

If the patient does not make satisfactory progress in one to two months of careful medical management, surgical treatment is indicated.

The accepted surgical treatment is a duodenojejunostomy. This operation when properly performed will give complete relief. In making the enteroenterostomy, care should be taken to make the opening large

Fig. 3.—Roentgenogram showing marked obstruction at the spine in oblique view.

enough so as to enable prompt emptying of the distended duodenum. The duodenum to the right of the spine is located retroperitoneally, which means that it is placed deep in the abdomen and requires extra dissection to mobilize it enough so that an enterostomy can be done. If the loop is long the operation is easily performed, but if it is short, it becomes a more difficult procedure.

Another surgical operation which can be performed consists in posterior gastroenterostomy accompanied with occlusion of the pylorus.

The latter may be accomplished by tying a heavy silk or cotton tape about the outlet, making it tight enough to obstruct the lumen but not to produce a necrosis.

In a series of 15 patients, 10 were relieved by gastroenterostomy and ligature about the pylorus and 5 by duodenojejunostomy.

My first positive diagnosis of duodenal regurgitation was made in 1928 for a boy 14 years old who in four months lost half of his weight, which decreased from 120 (54 Kg.) to 60 pounds (27 Kg.). He had been observed in two other hospitals for one month and dismissed

Fig. 4.—Roentgenogram showing prompt emptying of the duodenum following large duodenojejunostomy.

as having hysterical vomiting which was probably used as an excuse for not going to school. The patient complained of pain in the right upper area of the abdomen when attempting to eat, which was immediately followed by vomiting. Examination under the fluoroscope showed a distended duodenum, with large peristaltic waves and regurgitation into the stomach. It was evident that it was necessary to get the food into the intestines to the left of the spine. He was not responding to rest in bed with frequent small feedings.

The patient had become so dehydrated and emaciated that it was decided to do the easiest surgical operation possible to short circuit the duodenum. This consisted of doing a gastroenterostomy and producing an occlusion of the pylorus by tying a heavy double silk ligature about the outlet as described previously. After the operation, the patient stopped vomiting, started to eat promptly and regained his normal weight in two months.

He returned to school, went through law school and was admitted to the bar. Reexamination eighteen years later revealed that he never has had any return of his gastrointestinal symptoms and has enjoyed good health. Fluoroscopic examination at this time showed the gastroenterostomy to be functioning satisfactorily. It was also observed that the pylorus was functioning properly, with a normal outlet and duodenal

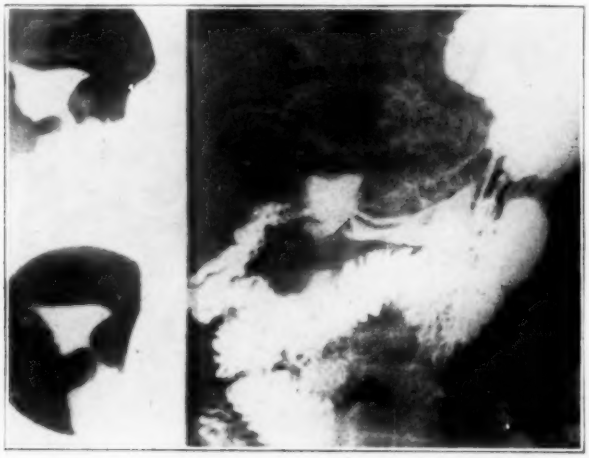

Fig. 5.—Roentgenogram of a patient operated on eighteen years previously showing prompt emptying of the stomach through the gastroenterostomy opening and the opening of the pylorus, which had been ligated by heavy silk at the time the gastroenterostomy was performed.

cap and a normal-sized duodenum. There is the question now of what happened to the heavy double silk ligature. It probably sloughed into the bowel and allowed the pylorus to reopen.

A similar surgical procedure was used for 9 other patients, with satisfactory results. On the last 5 a duodenojejunostomy was performed.

The most recent case (1946) of duodenal regurgitation involved a young woman of 25 years of age who lost 30 pounds (13.6 Kg.) in six months. She complained of recurring attacks of abdominal cramps for the past five years which had become so severe six months previously that she had sought relief. Roentgenologic examination at that time showed hyperperistalsis in the duodenum, but it was not looked on as an important finding. She was placed on a nutritious diet after a

tonsillectomy; however, her symptoms continued, consisting of cramps in the right upper area of the abdomen associated with nausea and a rapid loss of appetite soon after she began to eat. Repeated roentgenologic examinations showed a pronounced dilatation of the duodenum with large peristaltic waves and regurgitation into the stomach. An operation was decided on, and a large duodenojejunostomy was performed. After operation, the patient obtained prompt relief from her former symptoms and continued to make an uneventful recovery. She was able to return to her work after three weeks free from all symptoms and gaining in weight.

Prior to 1928, I observed, along with other clinicians, 4 cases during a period of fifteen years. The true condition was probably never recognized, but a lasting impression was left. Two of the patients were young women with pernicious vomiting who after years of medical management gradually became exhausted and died of malnutrition.

The other 2 patients had similar clinical symptoms of nausea and vomiting, but they have survived. One had her gallbladder removed, with no relief, and a gastroenterostomy was done later, but the pylorus was not occluded. She continued to have symptoms of nausea and refused to have further surgical treatment.

Another young woman presented a similar group of symptoms. A small duodenojejunostomy was done, which did not give complete relief. Later a gastroenterostomy was performed, but she still complained of nausea and occasional vomiting.

These 4 cases impressed me immensely and proved the truth of an often repeated saying of the late Dr. Bertram W. Sippy—"If our fore sight was as good as our hindsight, many things might have bee different."

CONCLUSIONS

Duodenal regurgitation should be suspected in recurring attacks of nausea and vomiting associated with loss of weight. The positive diagnosis is made by the radiologist on the observation of a dilated duodenum to the right of the spine, with delay of barium passing over the spine and with hyperperistalsis and regurgitation of barium back into the stomach.

Medical management should first be tried, but if satisfactory results are not obtained in one to two months, surgical treatment should be advised.

The surgical treatment of choice is a duodenojejunostomy, in which care is taken to make the anastomosis large, of 6 to 8 cm. in length, so as to enable prompt emptying of the dilated duodenum.

An alternative surgical procedure may be used consisting of gastroenterostomy and occlusion of the pylorus by ligation with heavy silk or cotton tape.

RELATIONS OF NERVE ROOTS TO ABNORMALITIES OF LUMBAR AND CERVICAL PORTIONS OF THE SPINE

J. JAY KEEGAN, M.D.
OMAHA

THE FINDING of diagnostic areas of sensory reduction, or hypalgesia, with loss of a single nerve root has made possible the accurate identification and location of nerve roots in their relation to vertebral sequence and abnormality. From this study it has been found that each nerve root maintains a constant position in the total series of vertebrae, regardless of a variable number of ribs or of transitional types of vertebrae. This observation is of considerable importance in the interpretation of nerve root syndromes in relation to lesions of the spine, particularly in the localization of posterolateral herniation of an intervertebral disk. It has made unnecessary the use of the spinogram in the great majority of typical cases and has clarified some misinterpretations of anatomic and pathologic variations of the spine not related to symptoms of nerve root involvement. This paper is presented in support of these statements and is based on careful neurologic observations in a large series of clinical cases with surgically verified compression, traction, injection or section of single nerve roots, reported in four previous articles.[1] The first paper, on the lower extremity, was published in 1943, and the accumulated material up to recent date is shown in table 1. Of the 1,030 cases of herniation of a lumbar intervertebral disk observed with dermatome hypalgesia, the location of the lesion of the nerve root was verified by operation in 588. The group of cases of lesions of cervical nerve roots, 96 in number (table 2), is not so large; yet the incidence of such lesions has been

Read at the fifty-fourth annual meeting of the Western Surgical Association at Memphis, Tenn., Dec. 7, 1946.

From the Department of Surgery, Service of Neurological Surgery, University of Nebraska College of Medicine.

1. Keegan, J. J.: (*a*) Dermatome Hypalgesia Associated with Herniation of Intervertebral Disk, Arch. Neurol. & Psychiat. **50**:67 (July) 1943; (*b*) Neurosurgical Interpretation of Dermatome Hypalgesia with Herniation of Lumbar Intervertebral Disc, J. Bone & Joint Surg. **26**:238 (April) 1944; (*c*) Diagnosis of Herniation of Lumbar Intervertebral Disks by Neurologic Signs, J.A.M.A. **126**:868 (Dec. 2) 1944; (*d*) Dermatome Hypalgesia with Posterolateral Herniation of Lower Cervical Intervertebral Disc, J. Neurosurg. **4**:115 (March) 1947.

sufficiently high during the past two years to indicate the commonness of this syndrome and to give evidence, in 31 verified cases, of the reliability of identification of the nerve root by dermatome hypalgesia.

Progress in this field of neurologic diagnosis has been retarded too long by acceptance of the dictum [2] that loss of a single nerve root produces no loss of sensation; by inability of other investigators to test carefully enough to detect and outline the definite dermatome area of hypalgesia which can be found, and by failure to recognize that discrete postero-lateral herniation of the nucleus pulposus of an intervertebral disk

TABLE 1.—*Clinical Cases of Dermatome Hypalgesia in the Lower Extremity Referable to a Single Nerve Root* *

Dermatome	No. of Cases	Per Cent	Verified by Operation
Third lumbar	14	1.3	5
Fourth lumbar	95	9.2	29
Fifth lumbar	389	37.8	230
First sacral	521	50.6	317
Second sacral	11	1.1	7
Total	1,030	100.0	588

* These data represent cases up to Jan. 28, 1947.

TABLE 2.—*Clinical Cases and Student Injections Showing Dermatome Hypalgesia in the Upper Extremity Referable to a Single Nerve Root* *

Dermatome	Cases	Student Injections	Total No.	Operation	Localization of Lesion Verified
Third cervical dermatome	7	0	7	1	1
Fourth cervical dermatome	5	1	6	1	2
Fifth cervical dermatome	10	1	11	2	3
Sixth cervical dermatome	15	2	17	7	9
Seventh cervical dermatome	21	1	22	5	6
Eighth cervical dermatome	18	3	21	3	6
First thoracic dermatome	12	2	14	2	4
Total	88	10	98	21	31

* These data represent cases up to Jan. 28, 1947.

compresses only one nerve root. Degeneration and separation of the nucleus pulposus of the disk, without extensive degeneration of the annulus fibrosus lead to posterior shift of the nucleus within the disk on stooping strain (fig. 1), with sudden pain or "catch" in the back and usually with no symptoms referable to the nerve root at this stage. If the nucleus breaks through the posterior longitudinal ligament (fig. 2), it usually is to one side of the midline, directly beneath a single nerve root as it leaves the dural canal. Direct observation at operation (fig. 3) shows only one nerve root flattened over the herniation tumor in a position which would make compression possible. Nerve roots

2. Foerster, O.: The Dermatomes in Man, Brain **56**:1 (March) 1933.

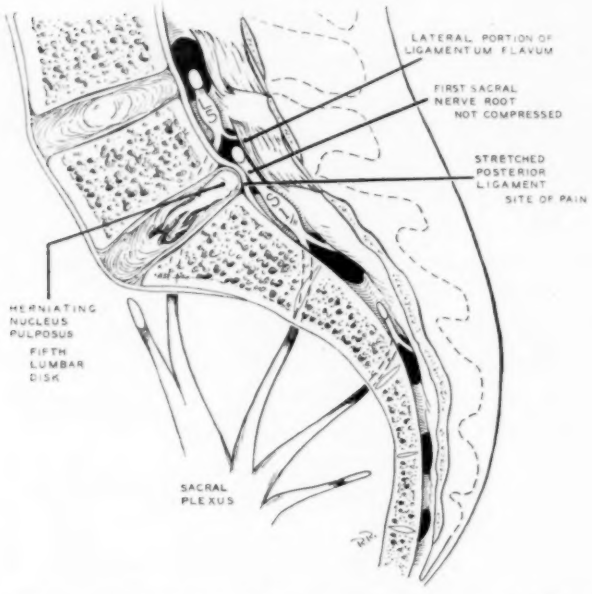

Fig. 1.—Sagittal view of herniating nucleus pulposus of the fifth lumbar intervertebral disk. Note position of the first sacral nerve root over the elevation of the posterior longitudinal ligament.

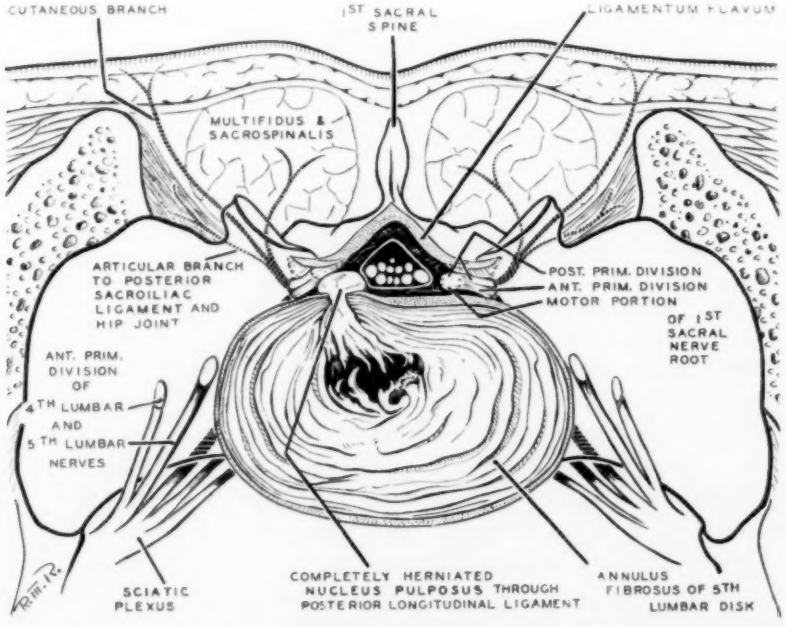
CUTANEOUS BRANCH
1ST SACRAL SPINE
LIGAMENTUM FLAVUM
MULTIFIDUS & SACROSPINALIS
ARTICULAR BRANCH TO POSTERIOR SACROILIAC LIGAMENT AND HIP JOINT
POST. PRIM. DIVISION
ANT. PRIM. DIVISION
MOTOR PORTION OF 1ST SACRAL NERVE ROOT
ANT. PRIM. DIVISION OF 4TH LUMBAR AND 5TH LUMBAR NERVES
SCIATIC PLEXUS
COMPLETELY HERNIATED NUCLEUS PULPOSUS THROUGH POSTERIOR LONGITUDINAL LIGAMENT
ANNULUS FIBROSUS OF 5TH LUMBAR DISK

Fig. 2.—Transverse view of herniation of the nucleus pulposus of the fifth lumbar disk (after Keegan [1b]). Note perforation of the posterior longitudinal ligament and compression of the first sacral nerve root.

of the cauda equina, which are not fixed at the site of the herniation, easily move aside unless the herniation is unusually large and fills most of the spinal canal. The nerve root of the corresponding disk emerges from the spinal canal nearly 1 cm. above the site of herniation and lies well lateral as it crosses the disk, where herniation of the nucleus does not commonly occur. Further evidence has been obtained repeatedly by traction on a single nerve root at operation, which leads to more evident postoperative dermatome hypalgesia and subjective complaint of numbness in one or more digits supplied by that root.

The method of testing for this sensory loss is quite simple but is evidently difficult for others to apply. All that is required is a light

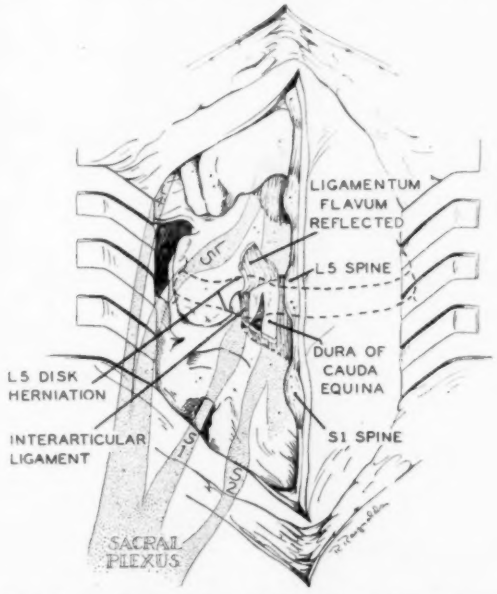

Fig. 3.—Surgical view of herniation of the fifth lumbar intervertebral disk compressing the left first sacral nerve root. Note the anatomic position of the fifth lumbar nerve root at a distance from this herniation.

pin scratch, adjusted so that the patient identifies it as sharp but not painful and reports it as definitely sharper as the pin passes out of the hypalgesic area into the normal zone. Figure 4 shows the dermatome pattern of hypalgesia thus outlined for each nerve root of the lower extremity. With this dermatome chart in mind, a careful history usually will indicate the nerve root involved, by the patient's fairly accurate location of the radiating nerve root pain or of the sensation of numbness in the dermatome distribution. Thus, with compression of the first sacral nerve root he will describe the pain as radiating down the midbuttock and the posterior aspect of the thigh and calf to

the lateral surface of the ankle or foot, often with a sensation of numbness in the little toe. With compression of the fifth lumbar root, the pain will be more lateral in the thigh and calf, radiating to the front of the ankle and foot, with a sensation of numbness in the middle toes, often including the great toe. With compression of the fourth lumbar nerve root, the pain will radiate down the lateral aspect of the buttock

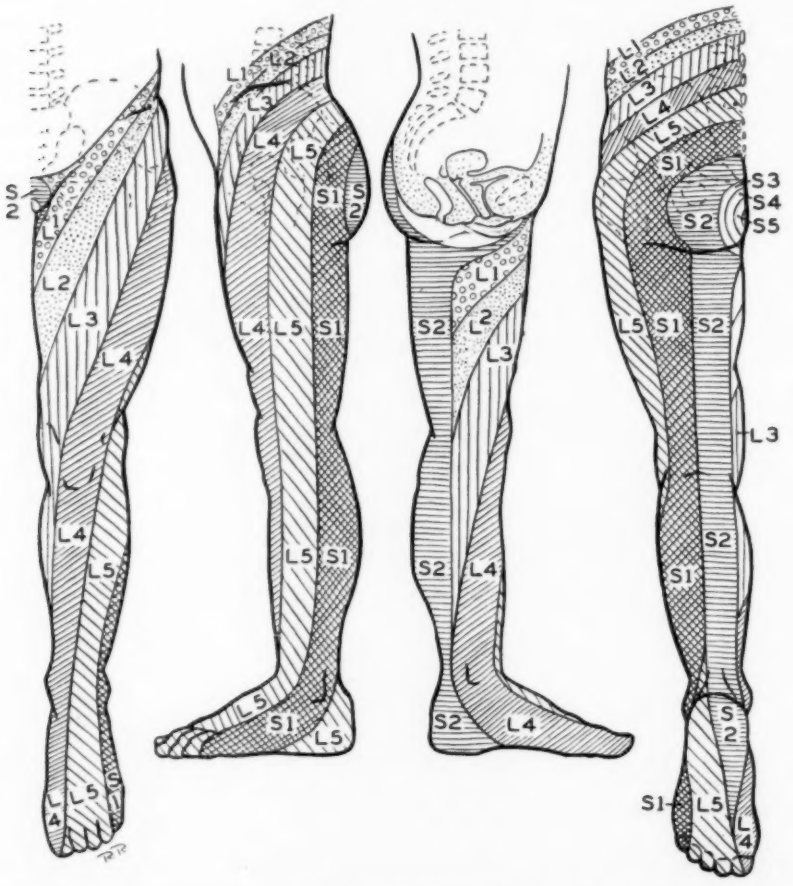

Fig. 4.—Dermatome chart of the lower extremity determined by the pattern of hypalgesia from loss of a single nerve root.

and the anterior surface of the thigh, over the knee cap and down the mesial surface of the tibia, also with numbness of the great toe. The dermatome pattern of hypalgesia for the upper extremity is shown in figure 5, and a similar diagnostic implication is possible from the patient's location of radiating pain over the scapula and down the arm, with a sensation of numbness in one or more digits. Thus, with compression of the sixth cervical nerve root the sensation of numbness will

be in the thumb; with compression of the seventh cervical nerve root, in the index and middle fingers, and with compression of the eighth cervical nerve root, in the little and ring fingers. A complete dermatome chart of the human body is presented (fig. 6), in which the new dermatome patterns of hypalgesia for the upper and the lower extremities are added to the generally accepted dermatome pattern for the trunk. It should be noted that the dermatome areas in this new chart are arranged in continuous serial order through the extremities, as in the trunk, contrary to the generally accepted anatomic teaching,[3] that there

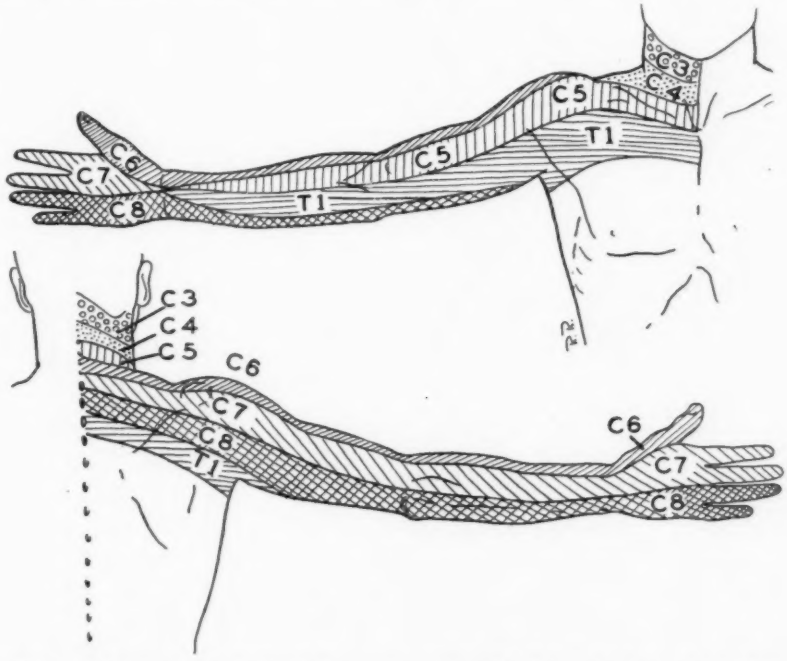

Fig. 5.—Dermatome chart of the upper extremity determined by the pattern of hypalgesia from loss of a single nerve root (Keegan,[1d] page 116).

is an outward migration of dermatomic nerve loops and sensory areas in development of the limb bud.

Anatomists also teach that there is great variation in distribution of the nerve roots to the extremities, based on variation in the root composition of the limb plexuses of man and on the reduction of presacral segments or lumbar vertebrae, as in man, particularly as com-

3. Sherrington, C. S.: Experiments in Examination of the Peripheral Distribution of the Fibers of the Posterior Roots of Some Spinal Nerves, Phil. Tr. Roy. Soc., London **184**:641, 1893. Bolk, L.: Die Segmentaldifferenzirung des nenschlichen Rumpfes und seiner Extremitäten, Morphol. Jahrb. **26**:91, 1898.

pared with the number in lower primates and other mammals.[4] Critical analysis of this concept indicates that it is not well founded (fig. 7). The only significant difference between man's five lumbar spinal vertebrae and the rhesus monkey's seven lumbar spinal vertebrae is the fusion of the monkey's sixth and seventh lumbar vertebrae with the sacrum of man, there being only three sacral vertebrae in the monkey.[5] The total number of twenty-nine vertebrae to the end of the sacrum is the same. The error has been in use of the first sacral vertebra

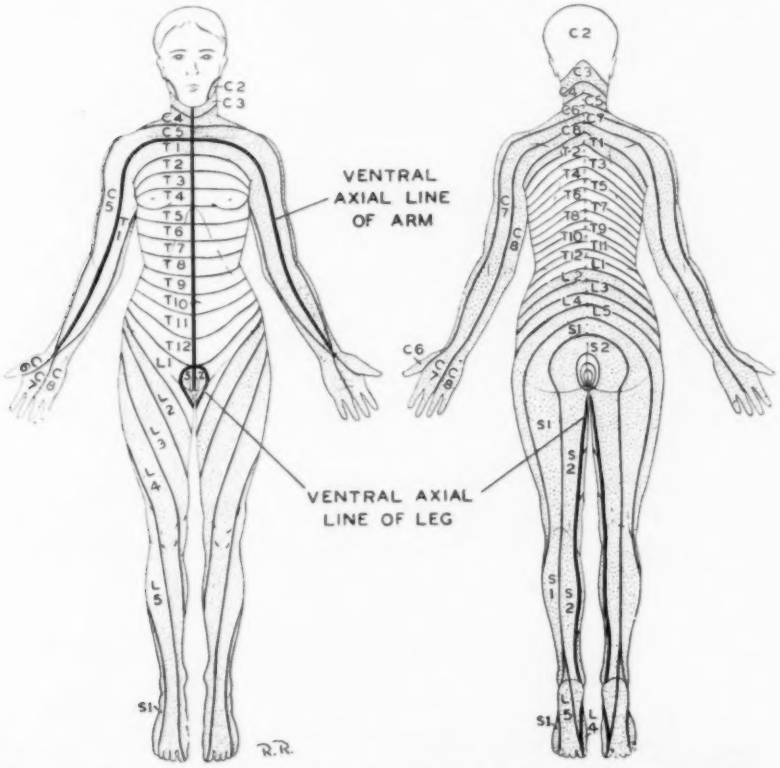

Fig. 6.—Dermatome chart of the human body with new dermatome patterns of the extremities combined with standard dermatome patterns of the trunk (Keegan,[1d] page 124). Note the serial continuity of the dermatomes in the extremities, as in the trunk.

as an anatomic landmark to identify and compare presacral nerve roots. A more stable primitive vertebra of the sacrum of mammals is the

4. Keith, A.: The Extent to Which the Posterior Segments of the Body Have Been Transmuted and Suppressed in the Evolution of Man and Allied Primates, J. Anat. & Physiol. **37**:18, 1902.

5. Hartman, C. G., and Straus, W. L.: The Anatomy of the Rhesus Monkey, Baltimore, Williams & Wilkins Company, 1933.

twenty-seventh of the total series,[6] or the third sacral segment of man, with which the lowermost portion of the ilium rather constantly articulates. Fusion of vertebrae above or below this primitive first sacral segment of mammals commonly occurs to meet mechanical needs, such as the erect posture of man. This should not be expected to change the peripheral distribution of nerve roots if it is recognized that the first and second sacral nerve roots of man are analogous to the sixth and seventh lumbar roots of the monkey and most lower mammals, or the twenty-fifth and twenty-sixth of the total series (fig. 7).

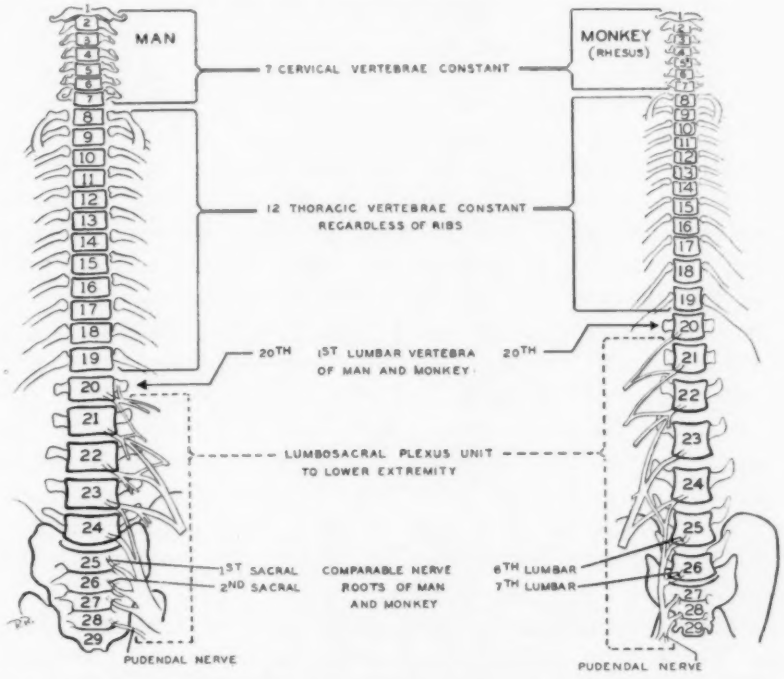

Fig. 7.—Comparison of the spine and lumbosacral nerve roots of the rhesus monkey (modified from Hartman and Straus [5]) with the pattern in that of man. Note the total number of vertebrae are the same and that the numerical relation of the origin of the nerve roots to the sacral plexus is the same.

This study of the cutaneous distribution of nerve roots to the extremities by outlining single nerve root dermatome hypalgesia, with verification by surgical exploration, indicates that there is no change of position of the nerve roots with the addition or reduction of lumbar vertebrae in man if the vertebrae are counted in total numerical sequence, and not by an arbitrary lumbar series defined by the quite variable first sacral segment or last rib. Thus, the commonly identified

6. Todd, T. W.: Numerical Significance of the Thoracolumbar Vertebrae of the Mammalia, Anat. Rec. **24**:261 (Dec.) 1922.

fifth lumbar nerve root, with its characteristic dermatome hypalgesia, has been found constantly emerging from the spinal canal between the twenty-fourth and the twenty-fifth vertebra of the total series, regardless of anatomic variation, and other nerve roots are found in corresponding position in the series.

This finding of the constancy of position and cutaneous distribution of the nerve roots in man contradicts the emphasis which previously has been placed on the variable root composition of the sacral plexus and invalidates interpretation of this variation as indicative of segmental evolutionary change. The union of nerve roots to form a plexus is a secondary and fortuitous arrangement to meet limb conformation in different animals. This should not be expected to alter nerve root distribution if all nerve roots to the lower extremity, from the first lumbar to the fourth sacral in man, or the second sacral in the monkey, are included, the combined lumbar and sacral plexuses being considered as a unit for the extremity. Thus, variable inclusion of the third or the fourth lumbar nerve root in one or the other plexus is of little significance in ultimate root distribution; likewise, separation of the pudendal nerve in man, derived from the fourth sacral nerve root, in contrast to its inclusion in the sacral plexus of the monkey (fig. 7), does not alter the ultimate distribution of this nerve, as in both cases it is derived from the twenty-eighth nerve root of the total series. While there may be variation of a few fibers in nerve root distribution, as identified by Sherrington,[7] with the terms prefixed and postfixed plexuses applied, and possibly represented in this study by variable inclusion of the great toe in subjective numbness with involvement of the fifth lumbar nerve root, this is not sufficient to alter significantly the dermatome pattern of hypalgesia for each nerve root.

The somewhat arbitrary division of the spine into cervical, thoracic, lumbar and sacral vertebrae, based on a variable number of ribs and variable fusion of vertebrae with the sacrum, is confusing in the identification of nerve roots. It would be better to identify the vertebrae by serial number, with the corresponding nerve root and disk located immediately below. This would necessitate a special designation for the nerve root which emerges between the skull and the first cervical vertebra as the suboccipital nerve. However, since one is rather firmly committed to the terms cervical, thoracic, lumbar and sacral vertebrae and nerve roots, the number in each group should be defined and limited to a normal of seven cervical, twelve thoracic, five lumbar and five sacral in man, regardless of a variable number of ribs or of transitional vertebrae at the lumbosacral junction. The confusion is

7. Sherrington, C. S.: Notes on the Arrangement of Some Motor Fibers in the Lumbosacral Plexus, J. Physiol. **13**:621, 1892.

even greater in identifying a nerve root in relation to herniation of an intervertebral disk. In the lumbar region the herniation compresses the nerve root one segment below the involved disk, not the corresponding nerve root, owing to the obliquity of emerging nerve roots at this level. In the cervical region the nerve roots pass out transversely and are compressed by herniation of the corresponding disk; but, owing to the identification of eight cervical nerve roots and only six true cervical intervertebral disks, the seventh cervical nerve root is observed to be compressed by the fifth cervical disk, and others correspondingly. Consequently, for clarity in describing this syndrome in the cervical region, it is necessary to state that the seventh cervical nerve root is

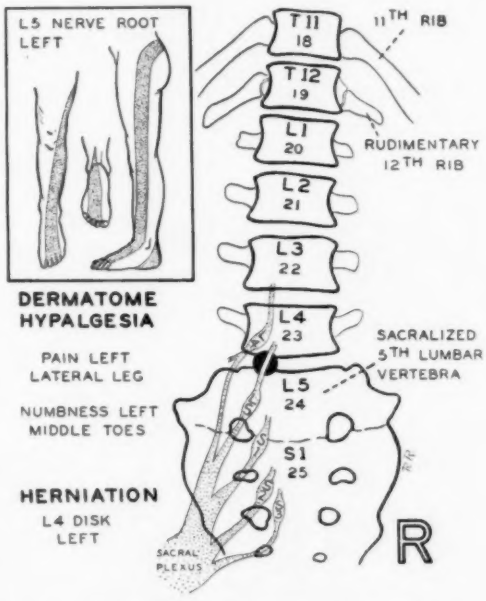

Fig. 8 (case 1).—Sacralized fifth lumbar vertebra and rudimentary twelfth rib, determined by total numerical series. Hypalgesia of the left fifth lumbar dermatome localized the herniation on the fourth lumbar disk, between the twenty-third and the twenty-fourth vertebra of the series, with surgical verification.

compressed by the disk between the sixth and the seventh cervical vertebra, and others likewise.

A few clinical cases illustrating the correctness of these anatomic interpretations will be presented, selected from a large number of cases with anatomic variations of the lumbar portion of the spine encountered in association with the syndrome of posterolateral herniation of the nucleus pulposus of an intervertebral disk.

CASE 1 (fig. 8).—The patient had only four lumbar vertebrae. The last pair of ribs were rudimentary and were to be differentiated from articulated transverse

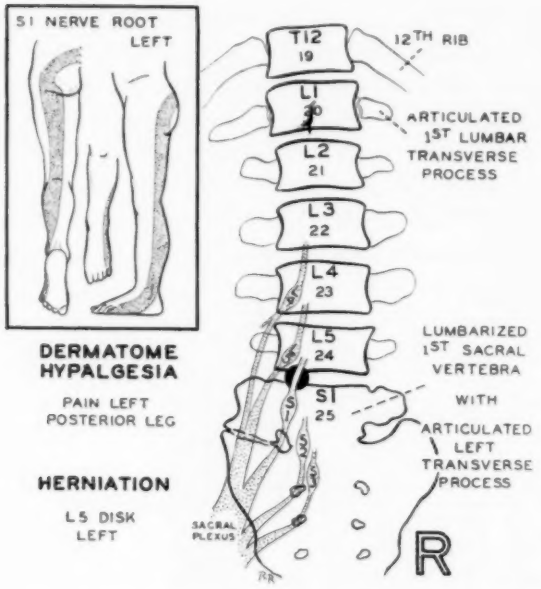

Fig. 9 (case 2).—Lumbarized first sacral vertebra and articulated transverse process of the first lumbar vertebra, determined by total numerical series. Hypalgesia of the left first sacral dermatome localized the herniation on the fifth lumbar disk, between the twenty-fourth and the twenty-fifth vertebra of the series, with surgical verification.

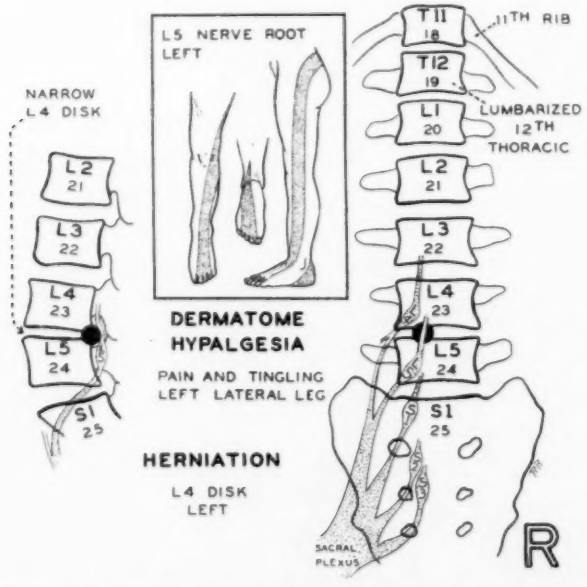

Fig. 10 (case 3).—Lumbarized twelfth thoracic vertebra, determined by the total numerical series and count of the ribs. Hypalgesia of the left fifth lumbar dermatome localized the herniation on the fourth lumbar disk, between the twenty-third and the twenty-fourth vertebra of the series, with surgical verification.

processes of the first lumbar vertebra by roentgenographic count of the number of ribs above. Only eleven ribs were found above these rudimentary ribs; hence, they represented the twelfth pair of ribs and the vertebra was the twelfth thoracic, or the nineteenth of the total series. Five lumbar vertebrae being accepted as normal for man, the fifth lumbar vertebra, or the twenty-fourth of the series, was completely sacralized; it should be recognized as a lumbar vertebra and not called the first sacral vertebra. The dermatome hypalgesia found in this case, with typical symptoms of herniation of the disk, was that of the left fifth lumbar nerve root. Recognizing that this nerve root is constantly compressed by herniation of the disk next above its emergence, or the fourth lumbar disk, and that this disk constantly is found between the twenty-third and the twenty-fourth vertebra of the

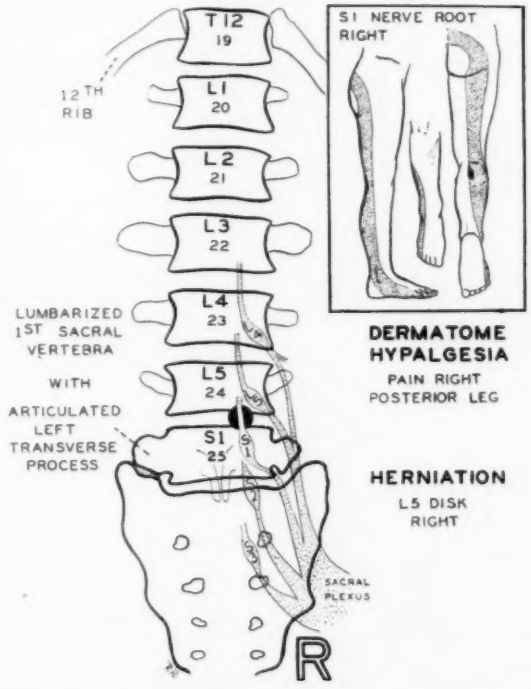

Fig. 11 (case 4).—Lumbarized first sacral vertebra, determined by total numerical series. Hypalgesia of the right first sacral dermatome localized the herniation on the fifth lumbar disk, between the twenty-fourth and the twenty-fifth vertebra of the series, with surgical verification.

total series, surgical exploration was directed to this site on the left side and the herniated nucleus pulposus observed, as indicated, over the last disk on this part of the spine.

Case 2 (fig. 9).—The spine had, similarly, four lumbar vertebrae and what appeared to be rudimentary ribs and a sacralized fifth lumbar vertebra. However, a count of the ribs showed twelve ribs above the rudimentary ones and hence identified the latter as articulated transverse processes of the first lumbar vertebra, or the twentieth of the series, and not the nineteenth, as in case 1. A count downward from this vertebra identified the fifth lumbar vertebra as normal and the

transitional vertebra as a lumbarized first sacral vertebra, not a sacralized fifth lumbar, as in case 1. The dermatome hypalgesia found in this case was that of the left first sacral nerve root, which would be compressed by herniation of the fifth lumbar disk, between the twenty-fourth and the twenty-fifth vertebra of the total series. Surgical exploration revealed herniation of the nucleus pulposus as indicated, in the correct serial anatomic position.

Case 3 (fig. 10).—The spine had six normally formed lumbar vertebrae. As the patient was of short stature and unlikely to have an extra vertebra in her spine, a count of the ribs was made by roentgenogram, showing only eleven ribs. Thus, the first free vertebra was identified as the nineteenth of the total series, or the twelfth thoracic, regardless of the absence of ribs. The lumbar sequence then was established and the last lumbar vertebra identified as the fifth lumbar, or

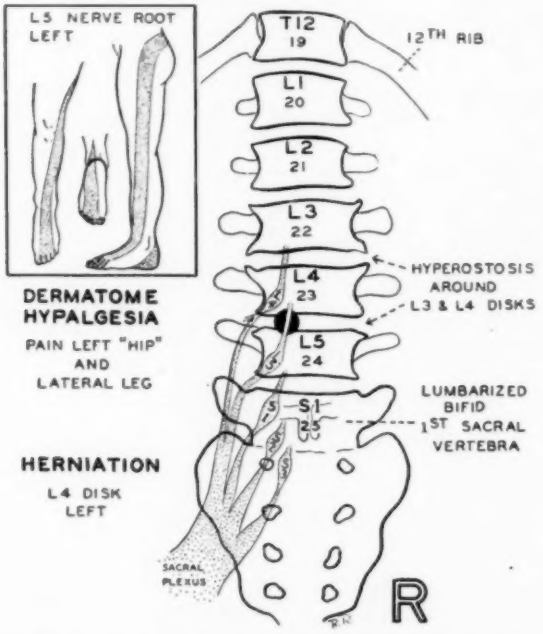

Fig. 12 (case 5).—Lumbarized first sacral vertebra, determined by total numerical series. Hypalgesia of the left fifth lumbar dermatome localized the herniation on the fourth lumbar disk, between the twenty-third and the twenty-fourth vertebra of the series, with surgical verification.

twenty-fourth vertebra of the series. The dermatome hypalgesia in this case was that of the left fifth lumbar nerve root, locating the herniation on the left side of the true fourth lumbar disk, between the twenty-third and the twenty-fourth vertebra of the total series, with surgical verification.

Case 4 (fig. 11).—The case was one of hypalgesia of the right first sacral dermatome with a lumbarized first sacral vertebra, locating the causative herniation on the fifth lumbar disk, between the twenty-fourth and the twenty-fifth vertebra of the total series, verified surgically.

Case 5 (fig. 12).—The case was one of hypalgesia of the left fifth lumbar dermatome with lumbarized first sacral vertebra. The causative herniation, of the

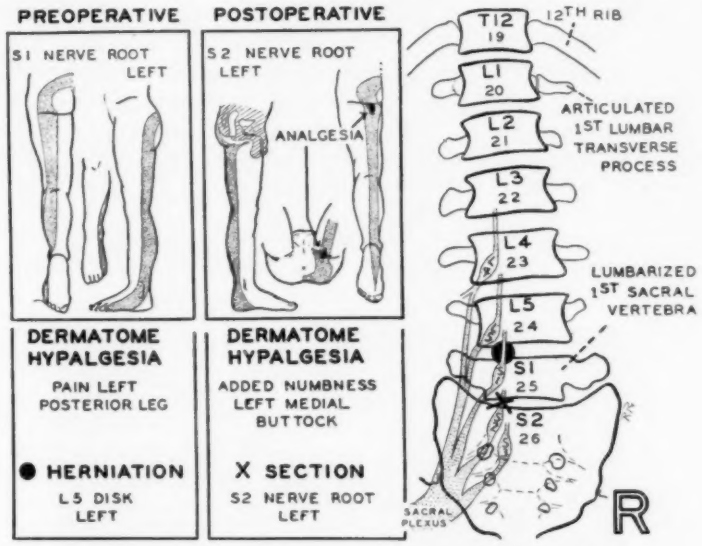

Fig. 13 (case 6).—Lumbarized first sacral vertebra, determined by total numerical series. Hypalgesia of the left first sacral dermatome localized the herniation on the fifth lumbar disk, between the twenty-fourth and the twenty-fifth vertebra of the series, with surgical verification. Section of the nerve root crossing the disk between the twenty-fifth and the twenty-sixth vertebra produced characteristic dermatome hypalgesia of the second sacral nerve root.

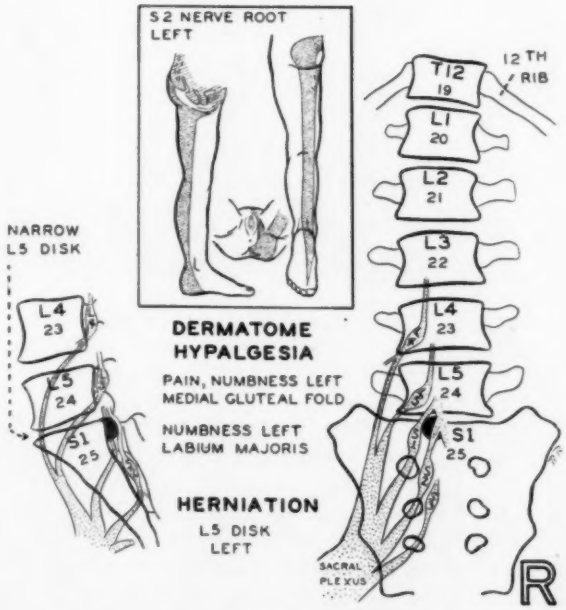

Fig. 14 (case 7).—Normal spine with five lumbar vertebrae. Dermatome hypalgesia indicated compression of the left second sacral nerve root. Surgical exploration showed discrete compression of the left second sacral nerve root over a low medial herniation of the fifth lumbar disk. Note anterior extension of hypalgesia to the pubic region.

fourth lumbar disk, was observed between the twenty-third and twenty-fourth vertebrae of the total series.

Case 6 (fig. 13).—The spine had six lumbar vertebrae, owing to lumbarization of the first sacral vertebra. This was not recognized before operation for herniation of the fifth lumbar disk, which caused pain and hypalgesia of the left first sacral dermatome. Exploration of the last disk of this portion of the spine revealed no herniation. Traction and partial section of the nerve root overlying this disk resulted in added postoperative numbness in the medial gluteal fold, with dermatome hypalgesia, identified as referable to the second sacral nerve root. The herniation causing hypalgesia of the first sacral dermatome was observed on the

Fig. 15 (case 8).—Roentgenogram of the lumbar portion of the spine with spondylosis deformans. Note that the hyperostosed vertebral borders are related to flattened intervertebral disks.

next to the last disk of this portion of the spine, later correctly identified as the fifth lumbar disk, between the twenty-fourth and the twenty-fifth vertebra of the total series.

Case 7 (fig. 14).—The case was one of a normal spine, with five lumbar vertebrae, with definite hypalgesia of the left second sacral dermatome and a sensation of numbness in the medial gluteal fold and the labium majus on the left side. Surgical exploration showed that the left second sacral nerve root was tightly stretched and flattened over a somewhat medially situated, discrete herniation of the fifth lumbar disk. The first sacral nerve root was displaced laterally but not compressed, and other sacral nerve roots did not appear to be compressed.

Many more cases of anatomic variation in the lumbar portion of the spine with correct localization of a herniated nucleus pulposus by dermatome hypalgesia could be reported, but space does not permit. It should be emphasized that count of the ribs roentgenographically must be made when there is any question of a rudimentary twelfth rib or an articulated transverse process of the first lumbar vertebra or a transitional type of vertebra at the lumbosacral junction, to identify correctly the vertebrae and disks in relation to the nerve roots. Although this method of localization of nerve roots in the total vertebral series has been found reliable when a definite dermatome pattern of hypalgesia can be found, it must be recognized that a lesser degree of,

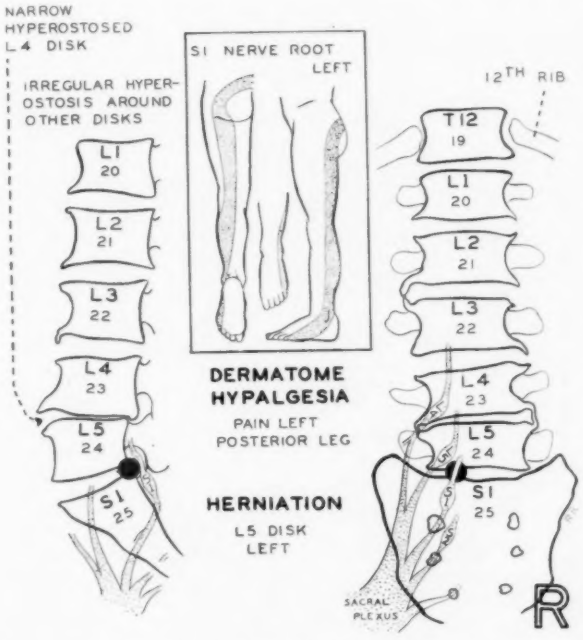

Fig. 16 (case 9).—Lumbar portion of the spine with irregular, hyperostosed vertebral borders surrounding narrowed intervertebral disks, particularly the fourth lumbar disk. Hypalgesia of the left first sacral dermatome indicated herniation of the normal-appearing fifth lumbar disk, verified surgically.

or intermittent compression of, the nerve root may not give a definite outline of hypalgesia. In such cases the localization may be misjudged and the wrong disk explored, the herniation being usually encountered on the disk next above. However, postoperatively, after traction on the nerve root over the herniation, a definite correct dermatome pattern of hypalgesia for that nerve root, with subjective sensation of numbness in the corresponding toes, usually will be found. Another source of seeming error in the method is a more lateral or more

medial herniation than usual, as illustrated by case 7 (fig. 14), which may compress a nerve root above or below the usual one over that disk. Or two nerve roots may be compressed by a wide herniation, leading to more extensive hypalgesia and motor loss than usual. Careful analysis must be made in all cases before, at and after operation, to correlate properly symptoms and signs of nerve root involvement with the pathologic process present. A spinogram may occasionally be indicated for further evidence before operation, although, if surgical intervention seems warranted for relief of symptoms, the added exploration of an adjoining disk seems preferable to the possible complications and fallacies of obtaining the spinogram.

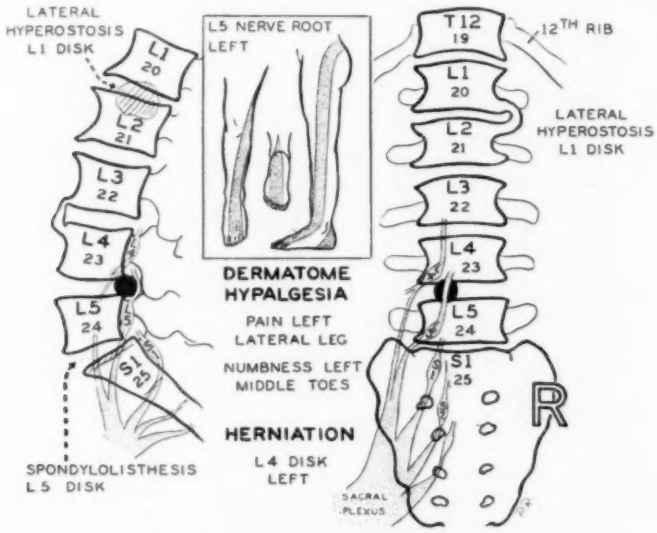

Fig. 17 (case 10).—Lumbar portion of the spine with irregular, hyperostosed vertebral borders around the first and third lumbar intervertebral disks and spondylolisthesis of the fifth disk. Hypalgesia of the left fifth lumbar dermatome indicated herniation of the normal-appearing fourth lumbar disk, verified surgically.

There has been considerable disagreement concerning the significance of anatomic and pathologic abnormalities of the lumbar and the cervical portions of the spine in the causation of symptoms. It is not intended to present this subject here; rather, I wish to emphasize that strictly lateralized pain, particularly that which radiates into one buttock, thigh and leg, or over the scapula into the arm, and hypalgesia of single nerve root distribution are symptoms of an organic lesion of a nerve root, and no other interpretation should be given to them. The pain from an anatomic or pathologic abnormality of the spine, to be distinguished from involvement of a nerve root should be located in the midline of the back, and interpretation of the need of spinal fusion be based on pain in the midline of the back, and not on lateralized nerve

root pain. Many patients with complete herniation of the nucleus pulposus of a lumbar intervertebral disk volunteer the information that the pain used to be in the back and now is all in one "hip" and leg. This indicates a remaining stable annulus fibrosus and spine, the symptoms at this stage being entirely lateralized nerve root pain. There would seem to be no indication for spinal fusion in such a case regardless of roentgenographic evidence of abnormalities of the spine.

The commonest pathologic abnormality of the lumbar portion of the spine seen in roentgenograms is hyperostosis of borders of vertebrae around a diffusely degenerated and narrowed intervertebral disk, commonly called spondylosis deformans. This pathologic process

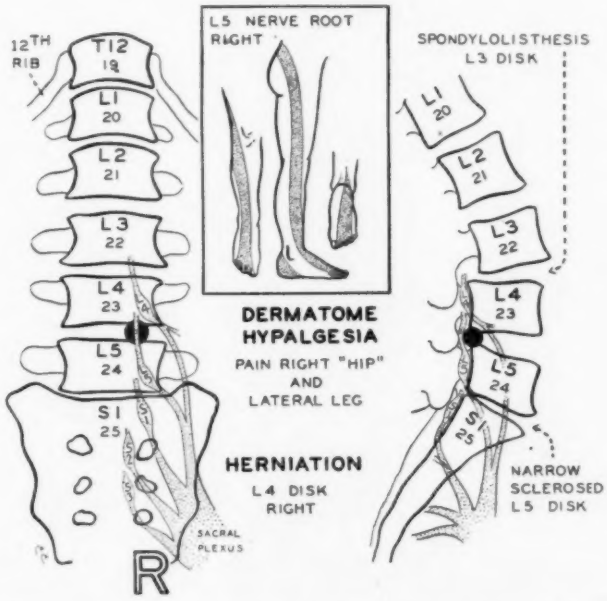

Fig. 18 (case 11).—Lumbar portion of the spine with spondylolisthesis of the third disk and narrow, sclerosed fifth disk. Hypalgesia of the right fifth lumbar dermatome indicated herniation of the intervening normal-appearing fourth disk, verified surgically.

should be described in relation to degenerated disk, caused by protrusion of the disk under compression strain due to heavy work with changes due to bone age in both the disk and the vertebrae. This diffusely degenerated disk protrudes more anteriorly and laterally than posteriorly, where nerve roots would be compressed, hence seldom gives rise to nerve root pain.

Case 8 (fig. 15).—The case presented a typical hyperostosis of the vertebral borders around degenerated disks, observed incidentally in a pyelogram in a patient without symptoms referable to a nerve root. The patient, a man aged 62, gave no history of special trouble with his back except for the usual increasing disability

with age. He had been a stone mason in Minnesota, worked on rolling stones or glacial boulders and stated proudly that in his day he could lift twice as heavy a stone as other men.

Case 9 (fig. 16).—This case presented extensive hyperostosis of vertebral borders, with symptoms of herniation of the nucleus pulposus of the fifth lumbar intervertebral

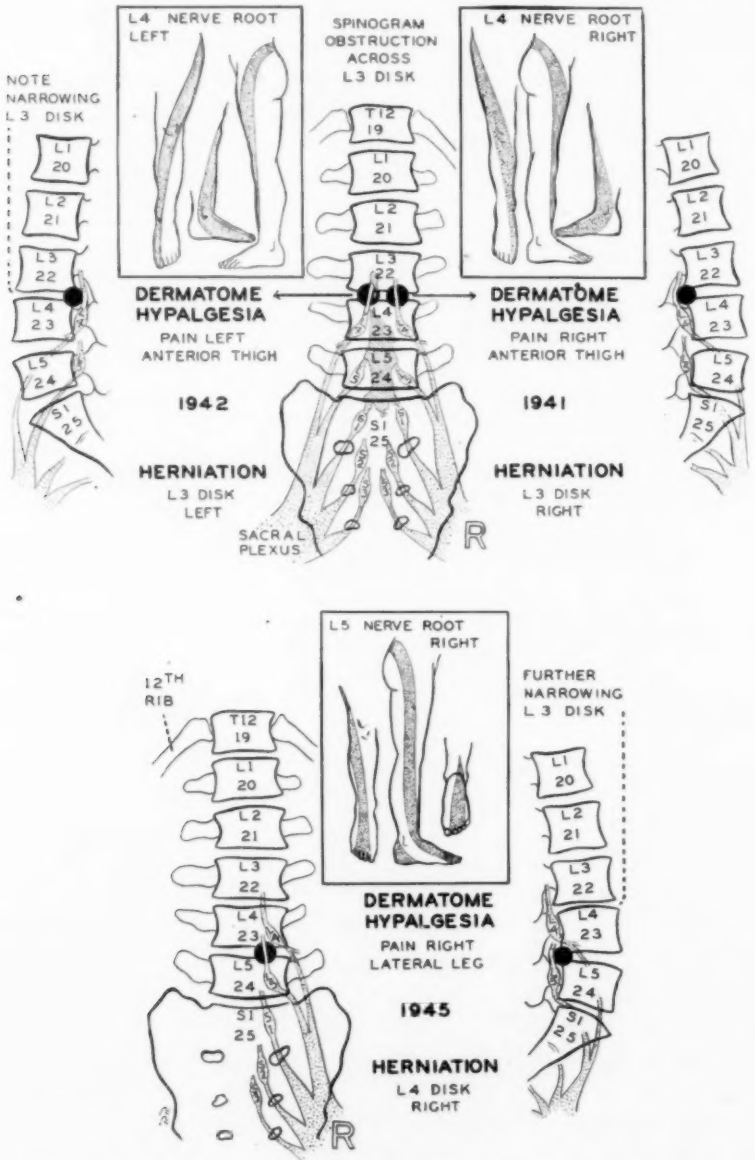

Fig. 19 (case 12).—Lumbar portion of the spine, showing progressive narrowing of the third disk with bilateral herniation and hypalgesia of the fourth lumbar dermatome. Later, hypalgesia of the right fifth lumbar dermatome indicated herniation of the fourth lumbar disk, verified surgically.

disk. Of particular interest was the completely obliterated and spontaneously fixed fourth lumbar disk without symptoms of nerve root involvement. The degeneration of this disk had passed the stage of acute herniation of the nucleus which the man presented. Dermatome hypalgesia in the distribution of the left first sacral nerve root placed the herniation on the more normal-appearing fifth lumbar disk, the diagnosis being verified and the condition relieved by operation.

CASE 10 (fig. 17).—The lumbar portion of the spine presented prominent hyperostosis of the upper vertebrae and first degree spondylolisthesis at the fifth lumbar disk. Hypalgesia of the left fifth lumbar dermatome indicated herniation of the nucleus of the normal-appearing fourth lumbar disk, the diagnosis being verified and the condition relieved by operation.

CASE 11 (fig. 18).—The spine showed spondylolisthesis at the third lumbar intervertebral disk and a narrow, sclerosed fifth lumbar disk. The dermatome hypalgesia indicated compression of the right fifth lumbar nerve root by herniation

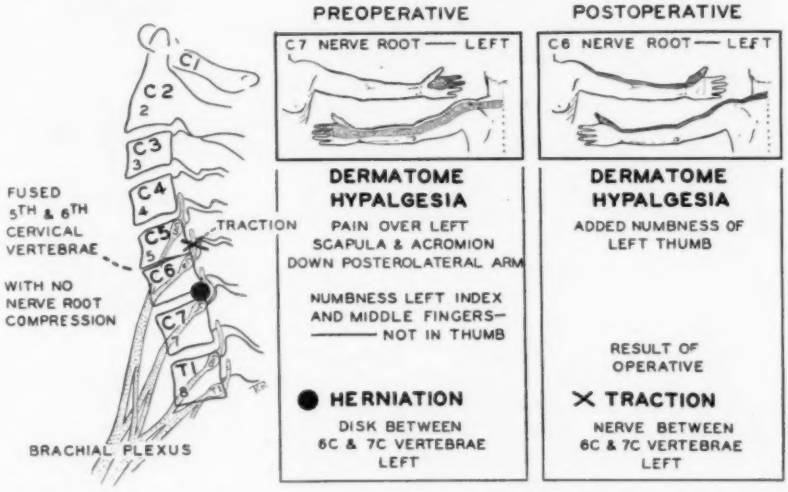

Fig. 20 (case 13).—Cervical portion of the spine with obliterated disk between the fifth and the sixth vertebra. Hypalgesia of the seventh cervical dermatome indicated herniation of the normal-appearing disk between the sixth and the seventh vertebra, verified surgically. Operative traction on the sixth cervical nerve root produced added dermatome hypalgesia of this root.

of the normal-appearing fourth lumbar disk, the diagnosis being verified and the condition relieved by operation.

CASE 12 (fig. 19).—A rather complicated sequence of multiple herniations of intervertebral disks and diagnostic dermatome hypalgesia developed over a period of four years. Pain radiating down the anterior surface of the right thigh and hypalgesia in the distribution of the fourth lumbar nerve root in 1941, with spinogram and operation, verified the herniation of the third lumbar disk on the right side. In the following year, 1942, similar pain and hypalgesia on the left side, with appreciable narrowing of the third lumbar disk, indicated left-sided herniation of this disk, verified surgically. Three years later pain again developed in the right leg, but this time it was located more laterally than anteriorly, and the dermatome hypalgesia indicated compression of the fifth lumbar nerve root. The old third

lumbar disk was further narrowed. Without regard for the new neurologic signs, the third lumbar disk was reexplored, without encountering further herniation. Exploration of the fourth lumbar disk disclosed a discrete herniation of the nucleus, compressing the right fifth lumbar nerve root, as indicated by the dermatome hypalgesia.

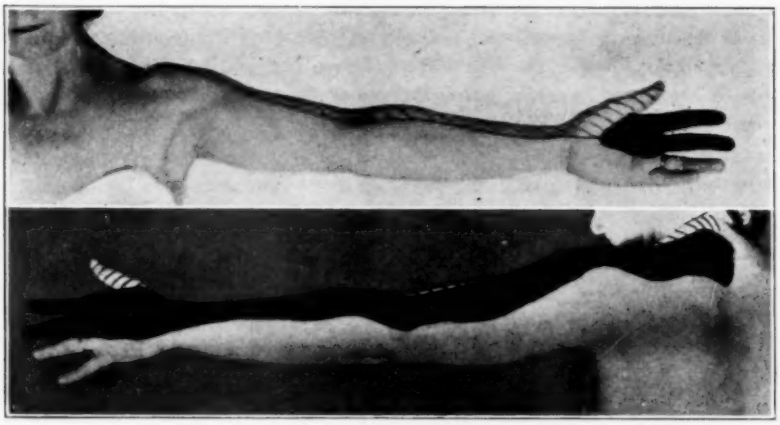

Fig. 21 (case 13).—Photograph of area of faintly reduced pain sensation, or hypalgesia, outlined for the seventh and sixth cervical nerve roots.

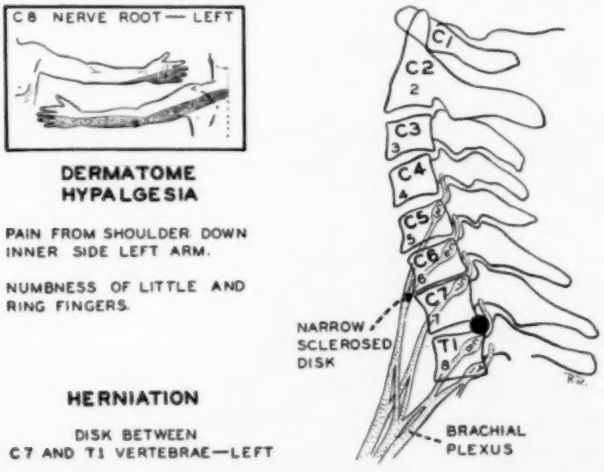

Fig. 22 (case 14).—Cervical portion of the spine with narrow, sclerosed disk between the sixth and the seventh vertebra. Hypalgesia of the left eighth cervical dermatome indicated herniation of the disk between the seventh cervical and the first thoracic vertebra, verified surgically.

In the lower cervical region, narrowing of intervertebral disks and surrounding hyperostosis of vertebral borders are observed commonly in roentgenograms, without nerve root symptoms, even when

oblique views may show the hyperostosis encroaching on the intervertebral canal. However, compression syndromes referable to a single nerve root do occur in this region and can be as well defined by dermatome hypalgesia as in the lumbar region.[1d] Time cannot be taken to discuss this syndrome but it again should be emphasized that the presence of pain and dermatone hypalgesia over the scapula, arm and hand referable to a single nerve root necessitates interpretation of a lesion of that nerve root, regardless of roentgenographic evidence of lesions elsewhere in the cervical portion of the spine. Two illustrations of pathologic involvement of the cervical portion of the spine, with findings referable to the nerve roots, are presented.

Case 13 (figs. 20 and 21).—Severe pain and dermatome hypalgesia occurred in the distribution of the left seventh cervical nerve root. Roentgenograms of the

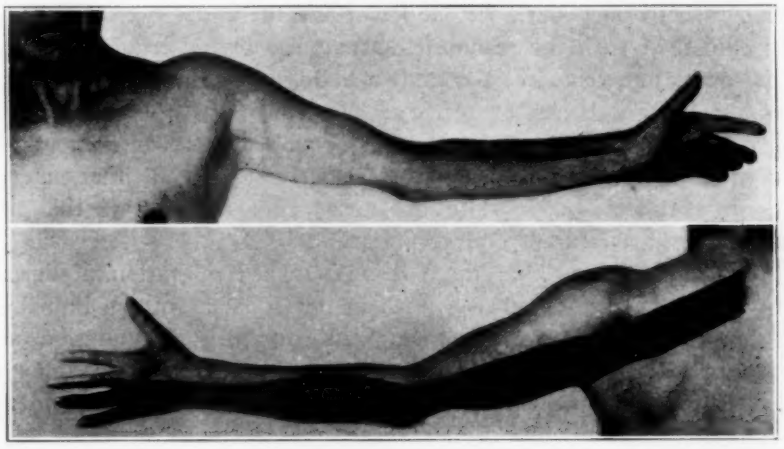

Fig. 23 (case 14).—Photograph of area of faintly reduced pain sensation, or hypalgesia, outlined for the left eighth cervical nerve root, showing atrophy of the intrinsic muscles of hand.

cervical region of the spine showed complete obliteration of the disk between the fifth and the sixth cervical vertebra, a lesion which would not involve the seventh cervical nerve root. Operation demonstrated the herniation of the nucleus at the proper anatomic site, between the sixth and the seventh vertebra. The sixth cervical nerve root was explored, and traction on it produced an increased sensation of numbness in the thumb and hypalgesia characteristic of the distribution of this root, with transient extensive motor impairment from loss of function of two nerve roots.

Case 14 (figs. 22 and 23).—The patient presented pain and hypalgesia typical of compression of the left eighth cervical nerve root, with motor loss in the intrinsic muscles of the hand. Roentgenograms showed a narrow, sclerosed disk between the sixth and the seventh cervical vertebra, a lesion which would not involve the eighth cervical nerve root. Operation demonstrated a herniation of the nucleus at the proper anatomic site, between the seventh cervical and the first thoracic vertebra,

with no herniation over the sclerosed disk above. The pain and motor loss were relieved by release of the nerve root, some hypalgesia persisting.

SUMMARY

The finding of diagnostic areas of sensory reduction, or hypalgesia, with loss of a single nerve root has made possible the accurate identification and location of nerve roots in their relation to vertebral sequence and abnormality.

Progress in this field of neurologic diagnosis has been retarded by acceptance of the dictum that loss of a single nerve root produces no loss of sensation, by failure to test accurately for this loss of sensation and by lack of recognition that posterolateral herniation of the nucleus pulposus of an intervertebral disk commonly compresses only one nerve root.

New dermatome charts for the lower and the upper extremities have been combined with the standard dermatomes of the trunk to furnish a new dermatome chart of the human body, which should be useful in neurologic diagnosis and anatomic teaching.

An accurate history of distribution of pain in cases of compression of a single nerve root by posterolateral herniation of an intervertebral disk often suffices to indicate the nerve root involved if this new dermatome chart is used for interpretation.

Anatomic teaching that there is an outward migration of dermatomic nerve loops and sensory areas in development of the limb bud, and that there are great variation and forward transmutation and suppression of vertebral and nerve segments in the human spine as compared with that of the lower primates is not supported by the evidence presented.

This study indicates that there is no change of position of the nerve roots with addition or reduction of lumbar vertebrae in man if the vertebrae are counted in total numerical sequence, and not by an arbitrary lumbar series defined by a quite variable first sacral segment and last rib.

The nerve roots and plexuses to an extremity should be considered as a unit which includes all nerve roots to that extremity, such as the first lumbar to the fourth sacral nerve root to the lower extremity in man. Separation or fusion into plexuses is a secondary arrangement which does not alter the ultimate root distribution to the skin.

The sacrum of lower primates is composed of three segments, the twenty-seventh, twenty-eighth and twenty-ninth vertebrae of the total series. Addition or fusion of vertebrae above these segments to meet postural needs does not alter the segmental distribution of nerve roots in the total series.

The terminology of the human vertebrae, intervertebral disks and nerve roots is confusing, particularly in describing compression of a nerve root by herniation of an intervertebral disk. It would be simpler and more accurate to identify the vertebrae by means of a total numerical series, with the corresponding disk and nerve root immediately below.

Abnormalities of the lumbar or the cervical portion of the spine seen in roentgenograms should be interpreted independently of definitely lateralized pain and hypalgesia referable to nerve roots, as the latter is more accurate in localizing compression of the nerve root by posterolateral herniation of the nucleus pulposus of an intervertebral disk.

The important fundamental significance of this new delineation and interpretation of the cutaneous distribution of the segmental nerve roots in the extremities of man has not yet been recognized fully by neurologists and anatomists, but the number of cases on which it is based and its demonstrated dependability in neurologic diagnosis indicate that it will be generally accepted in time.

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DISCUSSION

Dr. Robert D. Schrock, Omaha (read by Dr. Kellogg Speed, Chicago): This excellent presentation by Dr. Keegan is limited to the diagnostic aspects of a condition producing pain in the lower part of the back and the lower extremity. For years a problem has been presented in disabilities concerned with the lower part of the back, evidenced clinically by a list of the trunk or scoliosis and reference of pain to the sciatic nerve. Textbooks use the term sciatic scoliosis for this syndrome. In the past ten years, a certain group of patients with this disability has been segregated by more detailed study, and it has been demonstrated that the so-called sciatica can be further divided according to the component parts of the nerve or the individual nerve roots. In other words, detailed study has personalized the components of the sciatic nerve, so that in this group of patients it can be stated that the pain is due to irritation of one of the nerve roots of the sciatic nerve. Dr. Keegan has demonstrated a simple, and in my experience a dependable, method for localization of lesions of the individual nerve root through changes in its sensory distribution.

This localization does not correspond with the older conception of the absence or indifinite localization of sensory signs with lesions of a single nerve root. It is difficult to cast aside ideas received in the formative years and regarded as true because they represented the best information then available. Dr. Keegan has demonstrated definite areas of reduction of epicritic sensation from loss of function of an individual nerve root in the extremities, and from this he presents a new dermatome chart.

It has been my privilage to watch closely the development of these dermatome patterns and to check personally with Dr. Keegan my findings against his own, and it is pleasing to note the high frequency of agreement as to localization. Our lack of agreement is coming closer to explanation as Dr. Keegan clarifies the problem by his consideration of the total numerical series of vertebrae, rather than the age-old classification of cervical, dorsal, lumbar, sacral and coccygeal vertebrae. He has given through illustrative cases an answer to a question fre-

quently regarded as of no importance. The question is whether in certain cases of congenital malformations at the lumbosacral level an individual vertebra is lumbar or sacral. It has been the common fault to employ the loose designation of lumbarized first sacral or a sacralized fifth lumbar vertebra for such an abnormal vertebra, depending on the major characteristics of the individual vertebra. Dr. Keegan shows the importance of exact identification for determination of the position of the involved nerve root.

This paper, based on analysis of over 1,000 cases of disabilities of the lower part of the back with unilateral signs of nerve root involvement, in only 57 per cent of which there have been operative attacks, indicates Dr. Keegan's conservatism. The discussion could reasonably have been made to cover the entire problem of pain in the lower part of the back, but the presentation was based entirely on the diagnosis of disability of the lower part of the back with lateralized pain.

Dr. Keegan, in our almost daily discussions, sometimes developing into stimulating arguments, does not claim, as have some neurosurgeons, that all disabilities of the lower part of the back are due to herniation of the nucleus pulposus of an intervertebral disk. He presents a dependable technic for evaluation and accurate localization of compression of nerve roots in certain types of disability of the lower part of the back with pain radiating into one lower extremity. In my experience, the technic is simple and accurate.

HERNIATED INTERVERTEBRAL DISK

Analysis of Ninety Cases

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POSTERIOR herniation of intervertebral disk in the lumbar portion of the spine has evoked much discussion in recent years and there is still great diversity of opinion concerning diagnostic criteria, methods of treatment and results obtained by various methods of treatment

The object of this report is to analyze 90 cases in which operation for herniated lumbar disk was performed at the University of Minnesota Hospitals between Aug. 1, 1942 and Dec. 31, 1945.

Prior to March 1944, a pathologic lesion of the disk was removed, when exposed, but spinal fusion was not performed. Operation was done in 43 cases during this period without spinal fusion. After March 1944, a spinal fusion was performed in every case in which a pathologic lesion of the disk was removed, and occasionally after exploration had not revealed such a lesion. During this second period operation was performed in 47 cases.

In analyzing the results of various types of operation for lesion of the intervertebral disk it is necessary that only cases of definite lesions of the disk be included in the analysis if one wishes to make an exact evaluation of what can be accomplished with these various procedures. Therefore, the 90 cases have been divided into two groups. The first group is composed of cases in which the surgical exploration revealed no definitely pathologic disk. Ten (11 per cent) of the cases fell in this group. The second group was comprised of cases in which a definitely pathologic lesion of the disk was observed at operation. Eighty (89 per cent) of the cases were in this group.

An intervertebral disk was not considered pathologic unless one of two criteria were fulfilled: Either the nucleus pulposus had ruptured completely through the annulus fibrosus and was lying free in the

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extradural space, or there was a definite bulging of the disk into the spinal canal, and when the annulus fibrosus was opened the nuclear material mushroomed sponstaneously into the epidural space. Of the 80 pathologic disks, 51 were definitely protruding but had not completely ruptured through the annulus fibrosus, and 29 had ruptured completely through the annulus fibrosus, the nuclear material lying free in the epidural space. In 10 of the total series of 90 cases, neither of these two criteria was fulfilled; for this reason, the findings at operation in these cases were considered negative. These criteria for pathologic disk are, perhaps, more rigid than those set up by most surgeons; when, however, either condition is present, every one familiar with such lesions would agree that the disk is pathologic. On the other hand, the terms "concealed disk" and "protruded disk" are used by some surgeons to designate the condition of disks which they consider abnormal. Whether a disk so designated is abnormal is questionable; certainly, there is much room for personal interpretation and speculation on the part of the surgeon who is faced with the choice of an exploration without results or the consolation of a diagnosis of a pathologic disk of this indefinite type. Because of variations in structure of the disk, it is difficult, if not impossible, to determine at operation whether a disk is abnormal merely by its consistency. It is true that the herniated disk has a typical bulging appearance and a soft, boggy consistency; but these signs are open to so much individual interpretation that their acceptance alone as evidence of a pathologic disk may be quite inexact and, therefore, evaluation of results in cases of this type would be correspondingly misleading. Analysis of the results obtained in these 80 cases of definite lesions of the disk would indicate that operation is followed by satisfactory relief when a lesion of the disk is removed and that spinal fusion does not improve the result. It has been unnecessary to perform a second operation to cut sensory roots or to free adhesions or to carry out any other procedure for relief of continued pain in any of these cases, except 1 in which spinal fusion was later performed.

In all 80 cases the abnormal disk was observed in the last two lumbar or in the lumbosacral interspace. In 6 cases the lesion was in the interspace between the third and the fourth lumbar vertebra; in 28 cases (35 per cent), in the interspace between the fourth and the fifth lumbar vertebra, and in 46 cases (58 per cent) in the lumbosacral interspace. This distribution follows closely the experience of other investigators.[2]

1. This period was chosen because the results for all patients operated on prior to Aug. 1, 1942 have previously been reported by Peyton and Levin.[6]

2. (*a*) Smith, A. D.; Deery, E. M., and Hagman, G. L.: Herniation of the Nucleus Pulposus: A Study of One Hundred Cases Treated by Operation, J. Bone & Joint Surg. **26**:821, 1944. (*b*) Verbruggen, A. H.: Herniated Nucleus Pulposus:

(Footnote continued on next page)

The disease was found to be much more common in men (60 cases) than in women (20 cases). The age incidence of the patients varied from 20 to 60 years, with the maximum number of patients in the 36 to 45 age group. These findings are similar to those reported by Bradford and Spurling.[2c] No significant correlation could be found between the age of the patients and the interspace involved by the pathologic disk.

The symptoms and signs presented by the patients were analyzed in an attempt to demonstrate any significant difference in relation to the interspace involved. Abnormal reflexes were found to vary to some extent, depending on the interspace, but otherwise no significant correlation could be made between symptoms or signs and the interspace involved.

Table 1 shows the incidence of reflex changes found in these cases. As would be expected, the achilles reflex, the arc of which is chiefly in the first sacral root, was diminished or absent in a significantly greater

TABLE 1.—*Changes in Reflexes in Relation to Interspace Involved*

	Location of Disk			Total	No Disk Seen at Operation
	L 3	L 4	L 5		
Quadriceps reflex					
Normal	3	23	34	60	8
Diminished or absent	3	3	11	17	0
No record	0	2	1	3	2
Achilles reflex					
Normal	1	12	6	19	5
Diminished or absent	5	15	38	58	4
No record	0	1	2	3	1

percentage of cases of herniated disk at the fifth than at the fourth lumbar interspace. However, in 5 of the 6 cases in which the lesion was at the third lumbar interspace the achilles reflex was also diminished or absent, but in this group were 2 cases in which the lesions were so large that they produced paraplegia. This tendency of hernations of the disk at the third lumbar interspace to be massive may explain the high incidence of abnormal achilles reflexes associated with this group. It is surprising to find that the quadriceps reflex was recorded as decreased in 11 cases with lesions at the fifth lumbar interspace, since the arc of this reflex is generally accepted as in the second, third and fourth lumbar segments. These reflexes were tested in all cases by experienced examiners, so we feel that the findings are reliable. It is possible that the reflex in these cases was only apparently diminished, owing to a protective muscle spasm as a result of pain.

A Report of Seventy-Five Cases Examined and Operated, Dis. Nerv. System **4**:165, 1943. (*c*) Bradford, F. K., and Spurling, R. G.: The Intervertebral Disc, with Special Reference to Rupture of the Annulus Fibrosus with Herniation of the Nucleus Pulposus, Springfield, Ill., Charles C Thomas, Publisher, 1945.

Two patients were admitted to the hospital with paraplegia. It is remarkable that both these patients had a lesion of the disk at the third lumbar interspace, where only 6 (7 per cent) of the lesions occurred. This experience with lesions at the third interspace producing paralysis, together with other reports in the literature, is indicative of a tendency of massive herniations to occur in this interspace. In 2 cases of herniated disk with paraplegia reported by Voris [3] the herniations were at the third lumbar interspace. Verbruggen [4] reported 8 cases of massive extrusion of an intervertebral disk verified at operation. In 2 of these cases the lesion was at the third lumbar interspace.

That the return of function after operation in cases with sereve compression of the cauda equina is unsatisfactory was shown by the report of Verbruggen.[4] Of the 8 cases in which he operated, the results were excellent in 1, good in 1, and fair in the other 6. In all the last 6 cases there was residual weakness, anesthesia or loss of sphincter control of varying severity. Voris,[3] on the other hand, reported that the symptoms were relieved by removal of the lesion of the disk. Our experience with 2 cases has been similar to that of Verbruggen. In both cases residual weakness and sensory changes of severe degree were present, and in 1 case severe impairment of the urinary sphincter persisted.

The pathologic group was compared with the nonpathologic group for significant difference in symptoms and signs. The incidence of typical symptoms and physical findings was somewhat less constant in those cases of the nonpathologic group, but almost every so-called typical symptom and finding of a lesion of the disk was present, in one or another of the cases in which no lesion was seen at operation, and sometimes several were present in a single case. When these differences in symptoms and signs are subjected to statistical analysis for significant differences, it is found that only the incidence of a history of exacerbations and remissions, incapacity for work and tenderness of the sciatic nerve were significantly different, being higher in the pathologic group.[5]

Of the 80 cases in which pathologic disks were proved to have been present, an unequivocal history of trauma was given in 63 (79 per cent). This is a higher incidence of trauma than has been reported by other authors [6] and is also higher than that in the previous series of cases of

3. Voris, H. C.: Sudden Extrusion of an Intervertebral Disc, Dis. Nerv. System **6**:80, 1945.

4. Verbruggen, A. H.: Massive Extrusions of the Lumbar Intervertebral Discs, Surg., Gynec. & Obst. **81**:269, 1945.

5. The data were tested by Fisher's "exact" test.

6. Spurling, R. G., and Thompson, T. C.: Notes on the Diagnosis of Herniated Nucleus Pulposus in the Lower Lumbar Region, Surgery **15**:387, 1944. Verbruggen.[2b] Bradford and Spurling.[2c]

herniated disk reported from this clinic.[7] Of the 10 cases in which no lesion was observed at operation, a definite history of trauma precipitating the illness was present in 6 (60 per cent).

The onset of symptoms was acute in the majority of the cases. This was true of both the cases with and the cases without pathologic disk. The duration of symptoms varied from one month (in a case of paraplegia) to twenty years. There was no significant difference between the pathologic and the nonpathologic groups as to duration of the symptoms.

All the patients in both groups complained of pain in the back. Sciatic pain was present in 89 cases. Only 1 man, in whom a pathologic disk was found, had not had pain in the distribution of the sciatic nerve. Pain was aggravated by coughing, sneezing or straining in 65 (81 per cent) of the cases in which a pathologic disk existed and in 6 (60 per cent) of the cases in which exploration revealed no lesion of the disk. In 69 (86 per cent) of the cases of pathologic disk there were histories of exacerbations and remissions of symptoms, while in 4 (40 per cent) of the cases of nonpathologic disk a similar history was obtained.

In 70 cases (87 per cent) of the pathologic group there was a history of complete incapacity for work for at least one week. In most cases, of course, capacity for work was impaired for a much longer period. Incapacity for work was also found in 5 (50 per cent) of the nonpathologic cases.

Scoliosis was observed in approximately one third of the cases in both the pathologic and the nonpathologic group. There may be a list to the side of the lesion or to the opposite side. A list to the side opposite the lesion was about twice as frequent as a list to the side of the lesion. Spasm of the paravertebral muscles was noted in 36 cases (45 per cent) of the pathologic group and in 4 cases (40 per cent) of the nonpathologic group. In 45 cases (56 per cent) of the abnormal group, tenderness was maximal over the involved interspace, and in another 20 cases (25 per cent) tenderness was present but was maximal over an uninvolved intergroup. In 45 cases (56 per cent) of the abnormal group, tenderness was present over an interspace. Tenderness over the sciatic nerve was noted in 35 cases (44 per cent) of the pathologic group and in 4 cases (40 per cent) of the nonpathologic group. Pain resulting from maneuvers which stretch the sciatic nerve was present in 75 cases (94 per cent) of the pathologic group and in 5 cases (50 per cent) of the nonpathologic group. In 14 cases (17 per cent) of the pathologic group stretching of the scatic nerve on the uninvolved side produced pain in the leg on the involved side. This observation was not made in any of the cases in which later exploration revealed no lesion. Weakness and atrophy of the muscles of the leg were seen in only a small number of cases, but no

7. Peyton, W. T., and Levin, J. D.: Posterior Herniation of the Intervertebral Disc: An Analysis of Sixty-Five Cases, Minnesota Med. **27**:263, 1944.

definite conclusions can be drawn regarding these findings because of the incompleteness of the records concerning this sign. Significant sensory changes were found in 38 cases (47 per cent) of pathologic disk and in 3 cases (30 per cent) of normal disk. This is a lower incidence of sensory disturbances than has commonly been reported to occur in this disease.[2]

Three of the 90 operations were reoperations for lesion of a disk in cases in which a pathologic disk had been removed previously. In all 3 operations a second pathologic disk was encountered. In 1 case the recurrence was at the same interspace, and in the other 2 cases a different interspace was involved. This incidence of involvement of a second interspace is so much greater than the incidence of lesions of the disk in the general population that it suggests that some degenerative change may be present in the intervertebral disks of certain people as the underlying cause of herniation of the nucleus pulposus.

A spinal fusion was performed in 1 case one year after the removal of a pathologic disk. This was done in an attempt to relieve the pain in the back, which had not completely disappeared on removal of the disk. The fusion did not change the severity of this pain. During the period under consideration, no other reoperations were performed—for section of sensory roots, spinal fusion or any other procedure for the relief of continued pain.

Routine anteroposterior and lateral roentgenograms of the lumbosacral portion of the spine were taken before operation and revealed that in 7 of the 90 cases there existed varying degrees of lumbarization of the first sacral vertebra; in 1, spondylolisthesis, and in 1, spina bifida occulta. This is a smaller incidence of these abnormalities than was recorded by Breck, Hillsman and Basom [8] in their review of 450 routine lumbosacral roentgenographic examinations on work applicants. This fact is of significance, since Deery [9] stated that preexisting instability of the back predisposes the patient to herniation of an intervertebral disk. This analysis of 90 cases would indicate that bony abnormalities evident on roentgenographic examination, which are thought to produce instability, are not predisposing causes of hernation of an intervertebral disk.

Narrowing of the interspace involved by the pathologic disk was observed in roentgenograms in 16 cases, but such narrowing was also found in an interspace other than the one involved in 8 cases. Narrowing of the interspace was also observed in 3 cases in which no lesion of the disk was seen at operation.

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8. Breck, L. W.; Hillsman, J. W., and Basom, U. C.: Lumbosacral Roentgenograms of Four Hundred and Fifty Consecutive Applicants for Heavy Work, Ann. Surg. **120**:88, 1944.

9. Deery, E. M.: Herniation of the Nucleus Pulposus as a Complication of Preexisting Low Back Instability, Surg., Gynec. & Obst. **77**:79, 1943.

There has been expressed in the literature a considerable difference of opinion concerning the importance of myelography as a diagnostic aid in this disease, and there is also variable opinion as to the type of contrast medium to be used if myelographic examination is made. Love [10] recommended the use of air myelograms in all cases. Verbruggen [2b] expressed the belief that the use of myelography is unwarranted. Key [11] stated that the myelographic procedure is no more accurate than a good physical examination. In this clinic air myelography was discarded in 1941 because it was felt that the interpretation of air myelograms was unreliable. Since that time, myelographic studies with iodized poppyseed oil 40 per cent or "pantopaque" (a mixture of ethyl esters of isomeric iodophenyl undecylic acids) has been used in selected cases. Many patients present such classic symptoms and signs that myelographic study is considered unnecessary, since an operation would be performed even if the myelograms showed no lesion. In other cases in which the findings are less definite, myelographic examination is carried out because the decision as to whether or not an operation should be performed may depend on the additional evidence obtained from the findings. Myelograms were made in 46 of the 90 cases. A correct roentgenologic diagnosis was made in 41 cases. In 3 cases a positive diagnosis of a lesion of the disk was made on roentgenologic examination but subsequent operation showed no such lesion. In 1 of these cases, however, there was to account for the defect a definite bony projection, which probably was an old ruptured and calcified disk. Since this, however, did not satisfy our criteria of a pathologic disk, the myelographic diagnosis is here recorded to be in error, but the reverse is probably true. In 1 case the myelographic evidence was negative, but subsequent operation (within two weeks) proved that a large pathologic disk was present. In the fifth, and final, of the cases in which the roentgenographic diagnosis was incorrect, the iodized poppy seed oil was injected into the subdural space, an occasional fault in technic which makes interpretation of the roentgenograms impossible. There were, therefore, two false positive and one false negative myelogram.[12]

In 1 of the 90 cases the ligamentum flavum was found to be definitely abnormal. There was degeneration of the ligament. Its central portion was replaced by caseous material, so that when it was first exposed and

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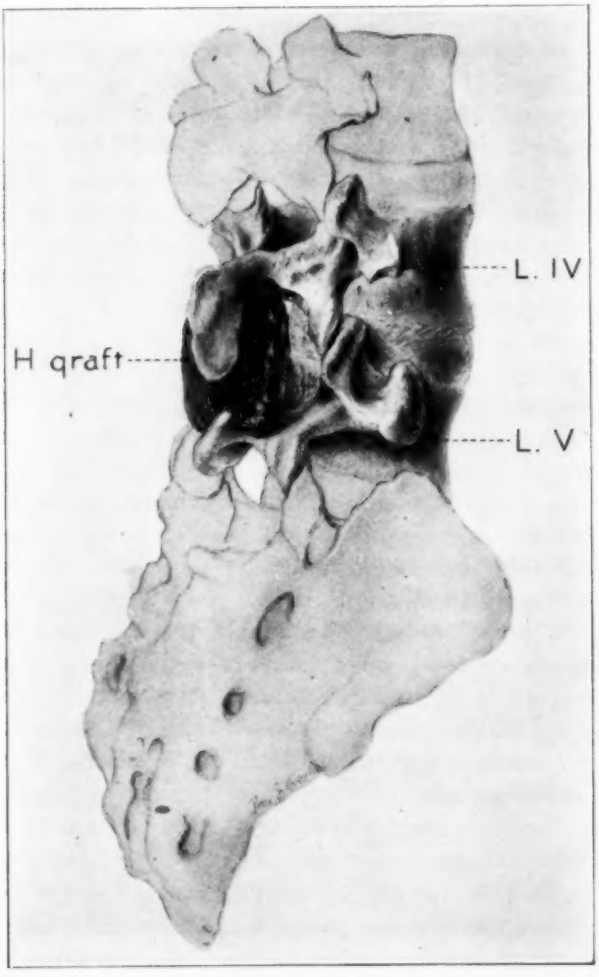
10. Love, J. G.: The Differential Diagnosis of Intraspinal Tumors and Protruded Intervertebral Discs and Their Surgical Treatment, J. Neurosurg. **1**:275, 1944.

11. Key, J. A.: The Conservative and Operative Treatment of Lesions of the Intervertebral Discs in the Low Back, Surgery **17**:291, 1945.

12. All myelographic studies were performed and interpreted by Dr. H. O. Peterson, of the department of roentgenology.

incised it appeared to contain a small dermoid cyst. Associated with this abnormal ligament was a pathologic lesion of the disk.

The surgical procedure employed at this clinic is similar to that in general use except that in all cases in which operation was done after March 1944 a spinal fusion was performed, using a Gibson [13] type of dovetailed bone graft (figure). At first these grafts were obtained



Spinal fusion with the Gibson type of bone graft.

from the tibia, but later they were taken from the crest of the ilium. With the spine flexed to separate the spinous processes, the graft is wedged tightly between the spines at the site of the involved disk. On

13. Gibson, A.: A Modified Technique for Spinal Fusion, Surg., Gynec. & Obst. **53**:365, 1931.

return from the flexed position, the graft becomes solidly wedged between the spinous processes. Bone grafts of this type were used in 45 cases in which a lesion was observed on exploration and 2 in which no lesion was encountered.

Postoperative complications were not frequent. Death due to pulmonary embolism occurred in 1 case and wound infections, in 2 cases. In 1 of the cases, with a massive compression of the cauda equina, urinary incontinence was present before operation, and this has remained as one of the most distressing symptoms. In 2 other cases there was temporary loss of control of the urinary sphincter, but in both cases this cleared completely before the patients' discharge from the hospital, three weeks after operation.

Grant,[14] in a survey of the postoperative results in 150 cases, found the patient at work with no pain in 52 per cent, working but with some disability in 37 per cent and not working in 11 per cent. Shinners and Hamby,[15] in a follow-up study, found that 54 per cent of their patients had some residual pain in the leg and 57 per cent had pain when working. Verbruggen [2b] classified his results in 75 cases as excellent (15 per cent), good (68 per cent), fair (11 per cent) and poor (6 per cent).

We have been able to follow 79 of the 90 patients in the outpatient clinic for a period of at least six months after operation, the average period for which these patients were followed being slightly over eighteen months. Only patients who were seen and examined are included in this analysis, for we find that many who claim on casual conversation that they have no symptoms admit on careful cross examination that some symptoms are present. Table 2 is a recording of the results for the patients thus followed. Not all findings recorded in these follow-up examinations are included in table 2. Each patient was also examined for pain on stretching the sciatic nerve, paravertebral muscle spasm, paravertebral tenderness, atrophy of the involved leg and reflex changes, but the results are not tabulated because they did not seem to add anything significant to evaluation of the functional result. The results in the cases in which bone grafts were made after removal of a pathologic disk (45 cases) and those in which no graft was made (35 cases) were recorded separately in table 2 so that the results might be compared.

Statistical analysis of the differences in table 2 reveals that there is no significant difference in the results for cases with bone graft and for cases without bone graft but unsatisfactory results are significantly more

14. Grant, F. C.: Operative Results in Intervertebral Discs, J. Neurosurg. **1**:332, 1944.

15. Shinners, B. M., and Hamby, W. B.: The Results of Surgical Removal of Protruded Lumbar Intervertebral Discs. J. Neurosurg. **1**:117, 1944.

frequent in the group without pathologic disk than in the group with pathologic disk.

The results following operation for lesions of the disk are divided into two large groups, satisfactory and unsatisfactory. No case was included in the group of satisfactory results if the patient had any disability whatever in his usual occupation, and many of these patients have occupations which require strenuous physical exercise.

TABLE 2.—*Results Following Operation*

	No Bone Graft Used		Graft Used		Total		No Herniation of Disk at Operation	
	No. of Cases	Per Cent	No. of Cases	Per Cent	No. of Cases	Per Cent	No. of Cases	Per Cent
Total number of cases	31		41		72		7	
Results								
Satisfactory								
No symptoms.....	5	16	9	22	14	19	1	14
Minor symptoms..	20	65	28	68	48	67	2	29
Unsatisfactory *								
Improved.....	4	13	2	5	6	8	3	43
Not relieved or severely handicapped	2	6	2	5	4	6	1	14
Pain in back								
Present.....	22	71	27	66	49	68	6	86
Absent.....	9	29	14	34	23	32	1	14
Pain in legs								
Present.....	16	52	29	71	45	62.5	5	71
Absent.....	15	48	12	29	27	37.5	2	29
Impairment of work capacity								
None.....	29	94	37	90	66	92	3	43
Slight.....	0	..	2	5	2	3	2	29
Moderate.....	1	3	0	..	1	1	1	14
Severe.....	1	3	2	5	3	4	1	14
Paresthesias								
Present.....	15		14		29		3	
Absent.....	16		27		43		4	
Weakness of leg								
Present.....	5		4		9		1	
Absent.....	26		37		63		6	
Sensation								
Normal.....	23		27		50		5	
Impaired.....	8		14		22		2	

* Since this report was written and these computations were made, an unsatisfactory result has been found in 1 of the previously untraced cases in which fusion was not done.

The group with satisfactory results was further divided into two subgroups, one including patients with no symptoms and the other patients with minor symptoms. These minor symptoms were mild discomfort of the back, mild pain in the leg, stiffness of the back or legs or annoying paresthesias.

The group with unsatisfactory results included patients who were improved but whose symptoms were sufficiently severe so that they were to some extent incapacitated for their usual occupations. Ten patients were included in this classification, 6 of whom are recorded as showing improvement and 4 as not relieved or as severely handicapped.

Mere tabulation of the results for these 10 patients as unsatisfactory, without further comment, would give an unpropitious impression of the results of operation for herniated disk as observed in this group of followed patients. Since it seemed desirable to set up certain criteria for each group in the classification of results and to adhere rigidly to these criteria, every patient who, after returning to work, was incapacitated for carrying on his usual occupation for as long as one week was classified as unsatisfactory, but the results for most of them were much better than this designation "unsatisfactory" would imply.

Therefore, a brief account of each of the 6 cases classified as showing an unsatisfactory result but improvement follows.

CASE 1.—A lesion of the disk was removed in June 1940 from the left side of the space between the second and third lumbar vertebrae of a farmer aged 41. He has been followed in the outpatient clinic at regular intervals since that time. He complained of pain in the left lower extremity when active but could tolerate up to four hours of light work, and up to July 1944 he was quite comfortable if inactive. At this time he cranked an automobile and had sudden, severe pain in the right buttock, which forced him to remain in bed for one week; intermittent episodes of pain on the right side then kept him completely incapacitated until February 1945, when a second lesion of the disk was removed from the space between the fourth and fifth lumbar vertebrae on the right side. Since this second operation he has again been rehabilitated to about the same work capacity he had before the appearance of pain on the right side, in 1944. His complaints since the second operation, however, have been in the left lower extremity.

CASE 2.—A physician aged 33 had a lesion of the disk removed from the right side of the fifth lumbar–first sacral intervertebral space and spinal fusion performed on Oct. 4, 1944. He was completely free of pain for four weeks and then experienced pain in the lower part of the back and down the distribution of the left sciatic nerve. Two weeks after onset of the pain in the left lower extremity he was put to bed with 15 pounds (6.8 Kg.) of traction, with prompt relief. The traction weights were gradually removed, and he was again out of bed and free of pain eight days after the traction was applied.

Since that time he has had no pain or distress in the back, and were it not for the fact that he had the aforementioned attack, which appears to have been due to irritation of the nerve roots on the side opposite the lesion of the disk, the result would qualify as excellent.

CASE 3.—A lesion of the disk was removed on Jan. 8, 1945 from the right side of the fifth lumbar–first sacral intervertebral space of a chauffeur aged 55. He was relieved of pain until April 2, 1945, when he again experienced pain, radiating down the right leg. After approximately three weeks in bed, his pains had completely subsided, and he returned to work and remained free from symptoms until Dec. 20, 1945, when he again had pain for two days; but since then, or for the past year, he has had no pain and has worked continuously.

In this case, the result would be very satisfactory were it not for two short periods of recurrent pain since his operation, nearly two years ago.

CASE 4.—A farmer aged 44 had an exploration of the left side of the fifth lumbar–first sacral intervertebral space on March 1, 1943. A very small fragment of loose disk material seemed to be present, but there was doubt even at the conclusion of the operation whether a lesion of the disk was really present.

Two months after operation he had less sciatic pain than before operation but was not entirely relieved. One year after operation he was doing light work, such as gardening and driving a tractor, but he still had pain in the lower part of the back and in the distribution of the right sciatic nerve when he did heavy farmwork.

It is quite possible that this case belongs in the group of negative results of exploration for lesion of the disk.

CASE 5.—On July 17, 1943, a lesion of the disk was removed from the right side of the space between the fourth and fifth lumbar vertebrae of a packing plant laborer. He did not go back to work until three months after operation. In the interval, and for two weeks after he returned to work, he was entirely free of pain; then he began to have pain in the distribution of the right sciatic nerve. This increased gradually, so that he was obliged to stop work after five weeks, when the pain gradually subsided.

Seven months after operation he reported that he was entirely free of pain when inactive or unless he became chilled, but he resented the fact that he was assigned work in the cooler room of the packing plant.

Because of continued disability, a fusion of the fourth and fifth lumbar vertebrae was performed March 22, 1944, or approximately eight months after the lesion of the disk was removed. This did not result in any essential change in his condition. He continued to complain when assigned to work in the cold room of the packing plant, but when given work in a warm atmosphere worked without complaint.

This is the only compensation case in which an unsatisfactory result followed removal of a lesion of the disk, but in this man there seemed to be a relation between his pain and dislike for the work to which he was assigned.

CASE 6.—A completely herniated lesion of the disk lying free in the epidural space was removed on Jan. 23, 1943 from the left side of the fifth lumbar–first sacral intervertebral space in a housewife aged 48. Two months later she reported that her condition was improved but not cured. Seven months after operation she reported that she had pain in the opposite, or right, lower extremity, but it was relieved by rest in bed. One year later, or eighteen months after operation, she was entirely free of pain; but at the time of writing, almost four years after operation, she again has pain in the lower part of the back and in the left lower extremity but does her own housework. She has also complained since operation of headache, a sensation of pressure on the top of her head, pain in the posterior cervical region, insomnia and numbness of her hands. Examinations since operation have never revealed any signs of irritation of the nerve roots. It is quite probable that this patient's continued complaints are for the most part, if not entirely, functional.

There were, therefore, in the group of 6 cases, 2 in which relief was obtained except for very short periods of incapacity for work, 1 which probably belongs with the group of negative explorations, 1 in which the continued symptoms seem to be functional in nature and 2 with partial incapacity for work and continued pain without known cause.

There were 4 cases in which very severe handicaps followed operation. In 2 of these 4 cases massive protrusions of the disk produced loss of function in segments below the level of the lesion, and the continued disability was due to incomplete recovery from this paralysis. In 1 of the 4 cases there were a postoperative wound infection and signs of severe involvement of the nerve rootlets from the first lumbar caudalward. Spinal puncture nine months after operation revealed that the

protein level of the spinal fluid was 110 mg. per hundred cubic centimeters and the fluid was slightly xanthochromic. It is assumed in this case with wound infection that arachnoiditis developed and that this was the cause of involvement of the cauda equina, which extended several segments above the site of the operation. In the fourth, and final, case in this group the patient's condition is considered to be unrelieved. A large lesion of the disk was removed and a spinal fusion performed, with complete relief for eight months, during which time the patient performed the heaviest type of work. Similar symptoms then suddenly developed on the opposite side. A spinogram seemed to demonstrate a lesion in another intervertebral space, but exploration revealed no lesion. Since the second operation, he continues to have pain in his back and in both legs so severe that he is at times incapacitated for work.

There were, therefore, in this group of 4 cases, 2 in which disability was due to incomplete recovery of function in paralyzed segments, 1 with sequelae from a wound infection and arachnoiditis and 1 in which pain, of unknown origin, persisted.

The suggestion has been made that the annoying minor symptoms which persist after the removal of a pathologic disk may be due to long-standing irritation of the nerve root, with permanent structural damage to the root. With this suggestion in mind, comparison was made of the duration of symptoms in the cases with excellent results (no symptoms) and those with good results (minor symptoms). It was found that of the cases with excellent results there were 9 (64 per cent) in which symptoms had been present more than ten years. Of the cases with good results but with residual minor symptoms, symptoms had been present less than six months in 24 (50 per cent) and more than ten years in only 5 (10 per cent). Thus, from this small group of cases, it would seem doubtful whether the duration of symptoms previous to operation affects the result which one may expect from the operation. It was impossible to analyze these two groups in relation to the severity of symptoms because the records did not give sufficiently accurate data on this point. It is realized that severity of symptoms, as well as their duration, should probably be included in an attempt to correlate trauma to the root with the results of operation.

The most common problem in the differential diagnosis of herniated disk, and the one which presents the greatest difficulty, is the differential diagnosis of psychoneurosis and a herniated disk. The symptoms of patients with psychoneurosis relating to the lower part of the back may mimic those of a herniated disk so closely and findings may be so similar that the differentiation is virtually impossible. For this reason, patients suspected of having a lesion of the disk are carefully studied for psychogenic disease before operation.

A critical attitude toward the physchoneuroses in the differential diagnosis of lesions of the disk has been developed in this clinic, for which support is found in the following observations: 1. Patients have been observed in this clinic the cause of whose disability was quite probably a psychoneurosis but for whom after prolonged observation, a lesion of the disk could not be ruled out; operation revealed no lesion, and the patient continued to have the same complaints. 2 Patients with more obvious psychoneurosis but with some signs of a lesion of a disk have been refused operation and have had exploration elsewhere by a surgeon experienced in this field, without any lesion being encountered. 3. Patients have come to this clinic with continuation of their complaints after operation elsewhere by surgeons experienced in operations for lesions of the disk, but on inquiry it has been impossible to get a record of a definite lesion having been observed and removed at the previous operation. Many of these persons have been at least temporarily relieved by mere suggestive therapy. Limitation of space does not permit the inclusion of illustrative case histories. As a rule the results are not good in cases of this type, and the patients are frequently subjected to secondary operations for reexploration, spinal fusion or section of the root.

This analysis of the cases in which definite lesions of the disk are removed demonstrates, on the other hand, that results are good and second operations for continued pain are rarely necessary. There are, of course, some cases in which both a psychoneurosis and a lesion of the disk are present. Some residual symptoms, after the lesion is removed, are prorbably to be expected in such cases.

SUMMARY

Ninety cases in which operation was performed for herniation of a disk are analyzed, with special emphasis on the results of operation. The disk was considered pathologic only in cases in which a loose fragment of disk tissue was observed lying free in the spinal canal or in which there were definite bulging and spontaneous protrusion of nuclear material when the annulus fibrosus was opened. In all others the disk was considered normal and the results of operation recorded as negative. Eighty pathologic and 10 normal disks were exposed at operation.

During part of the period covered by the collection of this material, spinal fusions were not performed after removal of lesions of the disk, and during the rest of the period fusion was done in every case after removal of the lesion. The relief obtained was essentially the same with simple removal of the lesion as with removal and spinal fusion. The results were satisfactory in the group of 80 cases in which a definitely pathologic disk was removed. Seventy-two of the patients were followed, and only 3 had continued pain or disability, of unknown origin. The results were not good in the 10 cases in which exploration

was considered to have revealed no lesion of the disk. This would indicate that simple removal of the lesion of the disk is a satisfactory operation and that improvement in results is likely to be realized through better selection of cases for operation rather than through the introduction of new operative procedures.

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DISCUSSION

DR. J. JAY KEEGAN, Omaha: This thorough analysis of 90 cases in which operation has been performed for herniation of a lumbar intervertebral disk, with comparison of results with and without spinal fusion, should aid in the solution of the problem of this syndrome. Every physician has the problem to deal with, for the condition is common, and it is important to seek better definitions of diagnosis and treatment. In such a complicated matter, it is not possible to establish infallible over-all rules, but each case must be analyzed individually and clear thinking and balanced judgment exercised.

There are two elements in this syndrome, as indicated by the familiar description of pain in the lower part of the back and sciatic pain. Pain in the lower part of the back is difficult to interpret in relation to ruptured intervertebral disk or other pathologic condition. In nearly every case in which true herniation of the nucleus pulposus of a disk develops, as defined in this study, initial pain is limited to the midline of the back and cannot be differentiated well from similar pain of other causes. It is only when the loose nucleus has protruded enough to compress a nerve root that pain becomes lateralized, and this should give the first clue that the lesion is a developing true herniation.

This lateralized pain may be represented at first only by an obvious list or protective scoliosis, but the patient will usually state, if questioned carefully, that the greater pain now is slightly to one side of the back or in the sacroiliac region. This early lateralized pain should be recognized as involving the nerve root, chiefly the posterior primary division of the nerve root, and should not be attributed to the ligaments or structures which this nerve division supplies. Later the anterior primary division of the nerve root becomes compressed sufficiently to send radiating pain down the thigh and leg in characteristic distribution for that nerve root.

When complete involvement of the single nerve root develops, sometimes rather suddenly, and persists more than two or three weeks, it usually means that the nucleus pulposus has completely herniated through the annulus and the posterior longitudinal ligament. The patient then will often volunteer the statement, "The pain used to be in my back and now is all in my hip and leg." Such a syndrome does not call for spinal fusion, regardless of lesions of the lumbar portion of the spine seen in the roentgenograms, for the symptoms are entirely those of compression of a single nerve root, diagnosable by the finding of dermatone hypalgesia.

As indicated by the absence of pain in the midback, the remaining annulus is firm and stable. If surgical intervention for herniation of the intervertebral disk could be limited to this type of case, the results would be excellent, as Dr. Peyton has shown. However, there is a large group of cases in which is presented a combined syndrome of nerve root pain and pain in the midline of the back, due either to incomplete herniation of the nucleus through the posterior longitudinal ligament or to a more diffuse degeneration of the annulus fibrosus, which protrudes rather than herniates.

These two syndromes may be distinguished to some degree, as the pain associated with discrete herniation of the nucleus is more likely to be intermittent, with "catches" in the back, whereas pain associated with diffuse degeneration of the disk does not show remission to this degree. It is difficult to know when fusion should be performed for such a condition. Sometimes longer waiting will permit the development of a true herniation of the nucleus, which can be removed satisfactorliy without spinal fusion.

In the second type of case, with symptoms referable to the nerve root, exploration should be made for possible removal of a partly herniated nucleus pulposus, and fusion be done at that time, the operation depending somewhat on the condition of the nucleus and demonstrable abnormal mobility at the involved interspace. The patient who presents only chronically disabling pain in the midline of the lower part of the back and no symptoms referable to nerve roots can safely have fusion without exploration of the disk.

Although spinal fusion is out of the field of neural surgery, a few anatomic observations may be permitted. Since most pain in the back requiring spinal fusion seems to come from degeneration of the intervertebral disk and instability at the site of the disk, it would seem that fusion within the intervertebral space would be more logical than an attempt to stop motion at this site by placing a strut across the posterior neural arch of the spine. The latter procedure may explain some of the poor results from fusion, together with the difficulty in performing fusion at the recessive angle at the lumbosacral junction, where most instability develops.

DR. JAMES S. HIBBARD, Wichita, Kan.: I have been extremely interested in the sensory examination which Dr. Keegan has presented so well today, and I realize its importance. Having noted the emphasis placed on diminution of the deep reflexes, my colleagues and I decided to point out the variation which one would find in 100 normal persons. We picked 50 hospital corpsmen and 50 Navy nurses; it was interesting to note that 22 of the subjects had definite inequality of the ankle jerks. One man had unilateral absence of the ankle jerk, which was not explained. In 1 woman the sign was difficult to elicit, but was present. Therefore in the neurologic examination one should not forget the normal variations.

We had a difficult problem overseas in dealing with sailors and Marines who wished to be on the sick list. In many cases the history was typical of a protruded disk and yet an accurate sensory and motor interpretation was impossible. This group included about 20 per cent of the patients with pain in the lower part of the back or with sciatic pain. They were malingerers but could not be designated as such in the Navy.

The psychoneuroses which Dr. Peyton has described were quite evident when I returned to the States. Cases of psychoneuroses were seen in a United States naval neuropsychiatric hospital at which I was associated with thirty-one psychiatrists. We attempted to work on the problem from the psychoneurotic standpoint. Many of the patients showed definite abnormal neurologic signs, but enough improvement was noted under psychiatric management to rule out a protruding disk.

In the evaluation of patients with pain in the lower part of the back we were helped considerably by a "sign," or "test," which was routine in the general physical examination. We called this test the "heel walking test." The patient was instructed to walk across the room flat-footed, on tiptoe and then on his heels. All our patients with lesions of a disk showed exaggerated pain in the back and leg when walking on the heels.

I should like to mention another group of patients. This group bears directly on the question of spinal fusion at the time of removal of the disk and includes

patients presenting additional lesions or congenital anomalies of the spine. From a neurologic standpoint, these patients may also have a protruded disk which needs removal.

(Slide.) I want to show this film because it illustrates one of the pitfalls of study with "pantopaque." There is a typical defect. This patient did not have pain referable to a nerve root. I am positive that the defect in this case was due to an epidural hemorrhage caused by the needle puncture.

(Slide.) The next roentgenogram also illustrates a possible error in studies with "pantopaque." In this case there appears to be an almost complete block at the fourth lumbar segment. Operation revealed no lesion representing the defect. This error has been seen and discussed by roentgenologists, but is not generally recognized.

(Slide.) This roentgenogram, taken with the patient standing, demonstrates lesions of bone in addition to a protruding disk. Impingement of the spinous processes on the vertebra below was first shown to me by Dr. A. E. Bence in 1929. This patient had a condition of this type, and he also had a definite lesion of the disk. At operation the disk was removed; the spinous processes were clipped off, and he had complete relief from the pain in his back and from his nuclear pain.

(Slide.) This anteroposterior roentgenogram shows the oblique position of the spinous processes as a result of impingement over a period of many years.

Dr. William T. Peyton, Minneapolis: I realize, of course, that there are many causes of pain in the back other than psychoneurosis and herniated intervertebral disk, but most of them are ruled out by physical, neurologic and roentgenologic examinations. The most difficult differential diagnosis is that of herniated disk and psychoneurosis, and most poor postoperative results are in psychoneurotic patients who are subjected to operation for lesions of the disk which are not present.

My associates and I make it our rule not to operate on a patient for a lesion of the disk unless he is disabled, and therefore we do not operate on patients who do not have root pain. There was only 1 patient in this group of 90 who had no pain referable to the nerve root.

We use spinograms as a diagnostic aid when the physical signs alone are not quite definite and decision for or against operation rests on the additional evidence to be obtained from the spinogram. A spinogram is not made if the findings are sufficiently definite that operation would be performed even though the spinogram revealed nothing abnormal. Spinograms were made for 46 of this series of 90 patients. We have seen the same deformity in the spinogram which Dr. Hibbard showed here, that is, almost complete blocking of the spinal subarachnoid space to the iodized poppyseed oil or other contrast medium, and we have become cautious in interpretation, since the associated disk is likely to be normal on exploration.

I still think that the so-called protruded disk is not a pathologic disk. I infer from what Dr. Keegan said that he thinks that it is. By a protruded disk I mean one that projects into the spinal canal but, if opened, does not have loose fragments. It has the consistency of a normal disk. There is considerable anatomic variation in the vertebral disk, and protrusion is apparently one of the variants. I know that the majority of surgeons who operate on lesions of the disk agree with Dr. Keegan that the protruded disk is a pathologic disk.

BILATERAL OOPHORECTOMY IN EARLY PREGNANCY

Cesarean Section at Term

H. K. BONN, M.D.
LOS ANGELES

Reis [1] stated:

> . . . Progestin [progesterone] which is the hormone of the corpus luteum of pregnancy is necessary in adequate amounts not only to prepare the endometrium for implantation but also to inhibit uterine contractions in order that the early pregnancy may remain attached to the decidua. In the early weeks of pregnancy these necessary amounts are produced by the corpus luteum of pregnancy. With the completion of placentation which is usually about the twelfth week the placenta takes over the function of the corpus luteum of pregnancy.

This succinct statement by Reis represents the commonly accepted fact that the presence of an ovary (producing the hormone, progesterone, of the corpus luteum) is necessary for the continuance of a pregnancy during the first twelve weeks. Considerable doubt is cast on such a premise by the case reported by Young [2] and the case to be reported here, which are similar both as to the acute abdominal condition necessitating operation and the probable duration of the gestation at the time bilateral oophorectomy was done.

A brief summary of Young's case follows:

> A farmer's wife aged 31 presented symptoms and signs warranting a tentative diagnosis of ruptured ectopic pregnancy. The previous history was not remarkable except that four years before she delivered a 7 month, macerated fetus; a year later she again became pregnant and delivered a living child at full term.
>
> At operation, a twisted ovarian cyst was removed; the other ovary was diseased and was likewise removed. The uterus was small, and since her last menstrual period was only two weeks overdue the diagnosis of pregnancy was questionable. Recovery from the operation was uneventful. Four and one-half months later the diagnosis of pregnancy was made beyond doubt. A living female child was delivered spontaneously about eleven days after the expected date of confinement. When seen one year later, the patient had been amenorrheic since the birth. The uterus was of normal size and shape, and there was no apparent atrophy.

In Young's case both ovaries were removed on March 23, 1940, and the last menstrual period had been on February 6; thus the preg-

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Read at the fifty-fourth annual meeting of the Western Surgical Association at Memphis, Tenn., Dec. 7, 1946.

1. Reis, R. A.: Causes and Treatment of Spontaneous Abortion, Illinois M. J. **80**:380 (Nov.) 1941.

2. Young, W. R.: Bilateral Oophorectomy in Early Pregnancy, Illinois M. J. **80**:132 (Aug.) 1941.

nancy could not have been present for more than thirty-five days if one adds ten days to February 6, as the most likely date of conception. Young added ten days to February 6, but if one adds fifteen days, the commonly accepted time of conception, the pregnancy in his case would have been of only thirty days' duration.

The following case is reported.

Mrs, W. E., aged 30, was seen on Jan. 9, 1943. According to her history, ten years previously, at the age of 20, a cesarean section was done by a competent colleague and friend in a midwestern city. The indication for the section, as stated to and by the patient, was the presence of a large intrauterine tumor, precluding a normal delivery. A living male child was delivered, and the patient was informed by her surgeon that a tumor of the uterine wall involved practically the entire fundus and that this tumor had not been removed. Recovery from the section was uneventful.

Two years later, in 1934, the patient and her husband were divorced, and later in 1934 the patient remarried. Another child was earnestly desired, but the patient did not become pregnant in the next eight years. During these years menstruation was regular, lasted four days and was painless. Her last menstrual period began July 20, 1942 and lasted four days, the amount being normal. She did not menstruate in August and believed that she was pregnant.

On September 8 the symptoms and signs of an acute abdominal condition appeared suddenly. Her husband, a chiropractor, summoned an osteopathic physician, who sent the patient to a small surburban hospital and operated on her at once. At operation an orange-sized cyst of the right ovary with a twisted pedicle and the accompanying tube were removed. Not content with this surgical procedure, the left ovary and tube were also removed. Apparently, the possibility of a pregnancy was not considered. Recovery was without incident.

In January 1943 the patient again consulted her osteopathic surgeon because of a large mass in the lower part of the abdomen. The cyst of the right ovary, the left ovary and both tubes were then located and sent to a competent pathologist, whose report stated that the ovarian cyst was of endometrial type, the other ovary being essentially normal. The tubes were normal. The patient was then advised to have roentgen treatment for supposed intra-abdominal endometriosis. The possibility of a pregnancy was apparently not considered even at this date, since a hormone test was not advised.

The patient was referred to me shortly after the pathologic diagnosis was made and roentgen treatment advised, because of dissatisfaction and the patient's repeatedly stressed belief that she was pregnant. No great skill was required to make the diagnosis of pregnancy, and the hormone test for pregnancy on Jan. 12, 1943 gave a positive reaction. The fetal heart beat was also heard at this time. A diagnosis of pregnancy of five and a half months with the probable presence of an intrauterine tumor was made. The patient was certain that a diagnosis of such an intrauterine tumor had been made at the first cesarean section. She expressed a desire that the tumor be not removed at the second section unless it was absolutely necessary.

I had not read Young's article at this time and was considerably puzzled by the fact that she had been able to retain her pregnancy thus far if the data as stated were true. Suffice it to say, having retained the fetus to the age of five and a half months, it was likely that the pregnancy would go to term, since other factors operate to retain the pregnancy after the third month.

The patient's prepartal course was normal. On March 13, 1943, a roentgenogram showed a fetus in utero with right occipital presentation and apparently normal development for the early part of the eighth month of gestation. A cesarean section was done on April 20, this date being considered to be seven to ten days prior to term. Operation revealed a sheet of omental adhesions was spread throughout the entire lower part of the abdomen, the bladder, the entire uterus to the posterior wall of the fundus and the lateral pelvic walls being completely covered. In view of the extent of the adhesions, no attempt was made to release them. The omentum covering the scar of the previous section was incised, and then the uterine wall, which was approximately 1¼ to 1½ inches (3.2 to 3.8 cm.) in thickness. When the uterus was opened, it became evident that a tumor involved the entire uterine wall of the fundus. The demarcation between the normal uterine wall and the tumor was easily identified. In addition, there was a fibroid the size of an apple near the cervix on the right lateral aspect and a smaller one nearby. A living female child was delivered and the placenta removed intact. Bleeding from the incised tumor was unusually free necessitating considerable ligation of individual vessels. The usual closure was done, and convalesence was entirely normal.

The patient has been amenorrheic since the cesarean section and has had the usual symptoms of surgical menopause, beginning about sixty days after the section and relieved by the use of ovarian hormones. From such data as are available from the statements made to the patient and her husband and from the pathologic report, it appears certain that both ovaries were excised completely at the original procedure for removal of the ovarian cyst. No effort was made to determine the presence of ovarian tissue at the time of the section because of the extensive adhesions. Likewise, a hysterectomy was not done, in view of the patient's request that such a procedure be not done at this time if it added to the risk. Such a policy was probably best in view of the unduly excessive hemorrhage from the incised wall of the uterine tumor and the necessity of releasing the firm, widespread adhesions. Examination one year after the section disclosed a uterus the size of two fists. The patient has declined to have further surgical treatment.

The patient's last menstruation began July 20, 1942, and the ovaries were removed on September 8. If one adds ten days to the date of the onset of menstruation, this gestation was of forty days' duration at the date of bilateral oophorectomy. If one adds fifteen days (instead of ten) as the most likely time of conception, then the duration of gestation was thirty-five days at the time of the bilateral oophorectomy. By either computation, the duration of the gestation was far less than the ninety days during which the ovarian hormone (progesterone) is believed to be necessary for the retention of pregnancy.

Seegar and Delfs [3] reported a case in which a Negro woman of 26, who had four full term, spontaneous deliveries, was operated on on May 29, 1939, the left tube and ovary being removed. The only menstruation between the date of operation, on May 29, and the date

3. Seegar, G. E., and Delfs, E.: Pregnandiol Excretion Following Bilateral Oophorectomy in Early Pregnancy, J. A. M. A. **115**:1267 (Oct. 12) 1940.

of admission to the hospital, on September 12, had been on July 2. On the basis of the symptoms and findings, a tentative diagnosis of ectopic pregnancy was made.

On September 13 a cyst of the right ovary and the right tube were removed. The uterus was noted to be enlarged and softened, giving the appearance of a uterus of early pregnancy. Labor occurred spontaneously on March 26, 1940, fourteen days before the expected date of confinement, a normal female child being delivered by breech extraction. Thus, the pregnancy of this patient went practically to term, although all ovarian tissue was removed on the sixty-third day of gestation.

Values for pregnandiol throughout the course of the pregnancy in this case were unusually low, the cause of which could not be evaluated.

Young, stimulated by the report of Seegar and Delfs, made one determination of pregnandiol during the last month of pregnancy in his case; this determination gave values well within the limits of normal and seemed to prove conclusively that the placenta was producing most of the progesterone.

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DISCUSSION

DR. THEODORE F. RIGGS, Pierre, S. D.: Before the estrogens were available, a married woman aged 23 reported to me with her first pregnancy. Examination revealed two firm masses, one on each side of the midline, and a third, softer, mass in the pelvis. Her pregnancy was of less than four and a half months' duration, and I suspected dermoids with the pregnancy. On examination a few weeks later the two upper masses appeared to have grown more than the pelvic mass. While I realized the danger, surgical intervention seemed necessary. Operation revealed bilateral dermoids, which were removed as gently as possible. The pregnancy went on to an uncomplicated, spontaneous delivery, the placenta doubtless substituting for the ovarian tissue which had been removed.

RADICAL MASTECTOMY

Prognosis After Survival for Five Years

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THIS paper is the report of an attempt to discover what happens eventually to women who have undergone the Halsted radical mastectomy and have survived five years or longer.

Since the opening of its department of surgery, thirty years ago, 598 such operations have been performed at the Henry Ford Hospital, 412 of them up to the end of 1941, with a mortality rate of 2.2 per cent. As the result of an intensive follow-up study of all radically treated patients with cancer of the breast, begun in 1930 and carried on without interruption despite obstacles of the war years, my colleagues and I have current follow-up information on all but 6 of the 412 patients (table 1). By recent check, we find that 177, or 43 per cent, survived their operation five years and more. Of these 177 patients, we have lost track of only 2 (table 2).

Three main considerations led us to study these five year survivors and their subsequent fate. First was an experience, many years ago, of discovering that a half-dozen women previously reported rather confidently as "five year cures" had all died subsequently of late developing metastases. A second consideration was that the operations on the present group of patients were performed in a similar manner and by a small group of surgeons. The chief surgeon of the hospital, Dr. R. D. McClure, perfomed 51 per cent of these operations; 4 other surgeons, another 41 per cent, while the remainder, 8 per cent, or 14 operations, were done by ten surgeons during their periods of training at the hospital. All operations, therefore, have conformed with the deliberately and thoroughly radical basic pattern established long ago by Halsted [1] and Meyer [2] and recently elaborated and illustrated by Haagensen.[3] The third consideration was a desire to discover either value or disadvantage in two or three variants in operative detail and postoperative treatment.

Read at the Fifty-Fourth Annual Meeting of the Western Surgical Association Memphis, Tenn., Dec. 7, 1946.

1. Halsted, W. S.: Surgical Papers, Johns Hopkins Hosp. Rep. **4**:297-350, 1894-1895.

2. Meyer, W.: Cancer of the Breast, Surg., Gynec. & Obst. **24**:553-577, 1917.

3. Haagensen, C. D.: A Technique for Radical Mastectomy, Surgery **19**: 1-131, 1946.

A follow-up program, properly conducted, is a continuous, persistent process. When the fate of a group of patients with radical treatment for a particular kind of cancer is studied, so to speak, by stopping the clock at a given point of time, and after a predetermined interval, one is at once confronted with four mutually exclusive subgroups. There are the patients known currently to be living and apparently well; the patients known to have died of intercurrent disease and apparently free of recurrence; the patients known to have died with recurrence or

TABLE 1.—*Data on Four Hundred and Twelve Patients Who Had Undergone Radical Mastectomy (1916-1941)*

Patient Group		Current Follow-Up Information	Completeness of Follow-Up Information
Total number of patients operated on.....	412	406	99%
Patients surviving five years.....	177	175	99%

TABLE 2.—*Data on Four Hundred and Twelve Patients with Radical Mastectomies (1916-1941) After Five Years*

	Total Number of Operations	Five Year Survivors	
		Number	Percentage
All patients.....	412	177	43
Patients with axillary nodes involved.....	251	74	29.6
Patients with axillary nodes clear.....	161	103	64

TABLE 3.—*Numerical Distribution of Subgroups of Patients (177) Surviving Radical Mastectomy Five Years or More*

	Axillary Nodes Involved	Axillary Nodes Clear	All Patients
Patients living and well.....	30	70	100
Patients who had died of intercurrent disease	16	13	29
Patients who had died of or were living with cancer	28	20	48
All patients	74	103	177

metastases, and the patients known to be living with recurrence. Since the patients in the present series known to be living with recurrence number only 7, they have, for purposes of analysis, been added to the larger group, of 41, known to have died of metastases. Table 3 shows the numerical distribution of these subgroups in our series.

PATIENTS WHO HAVE DIED OF METASTASES OR ARE LIVING WITH RECURRENCE

I shall first consider briefly the subgroup of 48 patients known either to have died of metastases or to be living with recurrence. There are 41 of the former and 7 of the latter. Their ages at operation tend

to fall slightly above 50, a corresponding slightly greater number of the women past 50 having passed the menopause before operation. Sixteen (one third) of these 48 patients lived five years but less than six years after operation (table 4). Of the 32 (two thirds) whose period of survival exceeded five years, 13 lived longer than ten years. Thus, in the subgroup whose fate to die of their cancer was sealed in spite of surgical intervention, there was achieved a ten year salvage of

TABLE 4.—*Postoperative Periods for Forty-Eight Patients Who Survived Radical Mastectomy Five Years or More But Who Died of or Were Living with Recurrence*

Postoperative Period	Number of Patients	Percentage
Under 6 years	16	33
6 to 9 years	19	40
10 to 14 years	10	21
15 to 19 years	2	4
20 years or more	1	2
Total	48	100

TABLE 5.—*Attainment of Life Expectancy of Forty-Eight Patients Who Survived Radical Mastectomy Over Five Years But Had Died of or Were Living with Recurrence*

Life Expectancy Attained	Number of Patients	Percentage
Less than one-half	33	69
One-half or better	15	31
Full or better	3	6

TABLE 6.—*First Appearance of Recurrence in Forty-Eight Patients Who Survived Radical Mastectomy Over Five Years But Who Had Died of or Were Living with Recurrence*

Period Before Recurrence	Number of Patients	Percentage
Under 5 years	20	42
5 to 9 years	20	42
10 to 14 years	6	12
15 to 19 years	1	2
20 years or more	1	2
Total	48	100

27 per cent. It may be noted in table 5 that 31 per cent had reached or exceeded half their life expectancy at the time of their operation.

We were greatly surprised to find how many years of apparent good health elapsed before signs of recurrence or metastasis first developed. As shown in table 6, metastases appeared between the fifth and the ninth year after operation in 42 per cent of the 48 patients, between the tenth and the fourteenth year in 12 per cent and during the fifteenth year or later in 2 per cent.

We have scrutinized our data on the 8 patients whose recurrence or metastases appeared ten or more years after operation without discovering any dependable clues to the extraordinarily protracted quiescence of their microscopic foci of cancer which remained after operation. The 8 patients were mostly middle aged, though there was a woman of 29 and another of 62. Of the 8, only 2 were operated on within a month after they had first noticed their growth; 2 others had the operation one year afterward. Four had involvement of axillary nodes; 5 had retraction of the skin or the nipple or of both. Three had roentgen treatment immediately after operation. Four had adenocarcinoma; 3, scirrhous carcinoma, and 1, medullary carcinoma. The only uniform factor in the clinical findings or in the treatment of these 8 women was primary operative closure of the wound without a skin graft. Only

TABLE 7.—*Data on Twenty-Nine Patients Who Survived Radical Mastectomy Over Five Years But Who Died of Intercurrent Disease*

Period of Survival	Number of Patients	Percentage
Under 6 years	7	24
5 to 9 years	7	24
10 to 14 years	9	31
15 to 19 years	4	14
20 years or more	2	7
Total	29	100

TABLE 8.—*Attainment of Life Expectancy of Twenty-Nine Patients Who Survived Over Five Years But Died of Intercurrent Disease*

Amount	Number of Patients	Percentage
Less than one-half	5	17
One-half or better	24	83
Full or better	13	45

in a much larger number of patients would such a common factor have even conjectural significance.

The clinical, operative and postoperative data on these 48 patients who ultimately died of their disease were further analyzed, without discoveries of statistical significance. That there were in this group twice the number of patients with retraction of the nipple and deep fixation of the growth and distinctly more patients with retraction of the skin are findings to be expected. As to the types of cancer, there was a slight predominance of adenocarcinoma and an understandable absence of colloid growths.

PATIENTS WHO DIED OF INTERCURRENT DISEASE

The next subgroup of patients to be considered is that in which death occurred after five years from intercurrent disease and without known recurrence or metastasis. This group numbers 29 patients. It will be dealt with briefly, for death from intercurrent disease always

leaves uncertainty regarding the possible presence of undetectable remaining foci of cancer. Only 5 of this group died in this hospital, where direct clinical observation or autopsy could give confirmatory evidence. The survival periods of these 29 patients after operation are shown in tables 7 and 8.

In connection with their survival, it should be noted that 83 per cent of these women had lived over one-half their life expectancy at operation and 45 per cent had exceeded that expectancy, several from four to nine years. Had these older women been handled timidly by less than radical operation or by other than operative treatment, many of them would have died sooner, and of their cancer.

With regard to other clinical and operative data on this group, only one curious finding stands out. Eighty per cent had retraction of the

TABLE 9.—*Data on One Hundred Patients Who Survived Over Five Years and Were Currently Living and Well*

Postoperative Periods	Number of Patients	Percentage
Under 6 years	11	11
6 to 9 years	36	36
10 to 14 years	24	24
15 to 19 years	17	17
20 years or more	12	12
Total number	100	100

TABLE 10.—*Attainment of Life Expectancy for One Hundred Patients Surviving Over Five Years and Currently Living and Well*

Amount	Number of Patients	Percentage
Less than one-half	45	45
One-half or better	55	55
Full or better	17	17

skin over the tumor at the time of operation. This striking frequency of retraction of the skin seems most plausibly explained by the greater ease with which retraction of the skin can occur and be detected in the atrophic elderly breast. The neglect of their tumors by these patients before they sought operation was no greater than that shown in the other subgroups.

PATIENTS LIVING AND APPARENTLY WELL

The third subgroup to be considered is that of the patients known to be living and well five years or more after operation. It numbers 100 persons, a larger number by one third than the other two groups combined. In addition to being a larger group numerically, a greater proportion of these patients have survived long periods of years, as is evident from comparison of table 9 with tables 4 and 7. Fifty-five per cent of these patients have to date lived over one-half their life expectancy, and 17 per cent have exceeded it (table 10).

With regard to clinical findings, there is one outstanding difference in this group, which undoubtedly is the principal factor in the longer survival of its members. Only 30 of the 100 patients were observed at operation to have metastases in the axillary lymph nodes, almost an exact reversal of the situation in the group who died of or are living with cancer. Other characteristics of the tumors of this group, such as retraction of the skin, were also less frequent, though not notably so. There were a few less adenocarcinomas and scirrhous and medullary carcinomas and more duct carcinomas, and the group contained two thirds of all tumors with colloid characteristics.

The data on the 12 patients of this group who have lived twenty years and over were examined to see whether their clinical and operative

TABLE 11.—*Primary Closure Versus Skin Grafting with Regard to Condition of Axillary Nodes*

Procedure	All Patients (177), Percentage	Patients with Axilla Clear (103), Percentage	Patients with Axilla Involved (74), Percentage
Skin grafting	32	25	41
Primary closure	68	75	59
	100	100	100

TABLE 12.—*Primary Closure Versus Skin Grafting with Respect to Survival Subgroups*

Procedure	Patients Living and Well (100), Percentage	Patients Who Died of Intercurrent Disease (29), Percentage	Patients Who Died of or Were Living with Recurrence (48), Percentage
Skin grafting	33	52	16.5
Primary closure	67	48	83.5
	100	100	100

observations gave an especially good theoretic prognosis of a long survival. Favorable factors were that one half had operations less than one month after noticing their tumor and that two thirds were free of axillary involvement. On the unfavorable side, it is to be noted that 6 of the 12 had scirrhous carcinoma, 4 adenocarcinoma and 1 medullary carcinoma, and 8 had some combination of retraction of the skin, retraction of the nipple or fixation to the thoracic wall.

EFFECTS OF MANNER OF CLOSURE OF THE WOUND

I now turn to two variants in operative procedure, clues to the advantages or disadvantages of which have been sought in this study. First is the manner of closure of the wound—primary closure versus partial closure, with immediate application of a split thickness graft to the defect. By reference to tables 11 and 12, it will be seen that

in nearly one third of the operations a graft was used and that it was used more often in cases with axillary metastases. Grafts were also used twice as often in the group of the patients who are living and well as in the group of the patients who have died of or are living with recurrence.

Table 13 indicates that there are definite differences in the time of wound healing in the cases with skin grafting and the cases with primary closure of the wound.

TABLE 13.—*Primary Closure Versus Skin Grafting with Respect to Effect on Time of Wound Healing in Series of One Hundred and Seventy-Seven Patients Surviving Over Five Years*

Time	Percentage of Patients	
	Skin Grafting	Closure
Under 1 month	4.5	11
2 months or less	72	62
3 to 4 months	21	18
5 months or over	7	20

TABLE 14.—*Primary Closure Versus Skin Grafting with Respect to Effect on Shoulder Motion and Edema of Arm for One Hundred and Seventy-Seven Patients Surviving More Than Five Years*

	Percentage of Patients	
	Skin Grafting	Closure
100% motion	79	91
Impairment	21	9
	100	100
Edema	56	59
No edema	44	41
	100	100

A split thickness graft rather dependably (in 72 per cent) secured healing in two months or less and rarely (in 7 per cent) resulted in greatly delayed healing. Although primary closure led skin grafting in cases in which healing occurred within one month (11 per cent), it also, by reason of the risk of sloughing of the wound edge, resulted in nearly three times (20 per cent) as many slowly healing wounds as did grafting. Table 14 indicates that more instances of impaired arm motion followed skin grafting than followed primary closure of the wound. There was no significant difference between grafting and primary closure in the incidence of postoperative edema of the arm. In recording the latter complication, minimal, and even transient, swelling was classified as edema.

IS BIOPSY AT OPERATION JUSTIFIED?

The final variant in operative procedure which we have attempted to evaluate from this study is the question of biopsy at operation. For many years it has been our practice first to remove, with a liberal amount of contiguous breast tissue, any clinically uncertain tumor of

TABLE 15.—*Percentage Distribution of Biopsy at Operation in Subgroups of Patients Surviving Five Years or More*

Procedure	All Patients (177), Percentage	Patients Living and Well (100), Percentage	Patients Who Died of Intercurrent Disease (29), Percentage	Patients Who Died of or Were Living with Recurrence (48), Percentage
Biopsy	55	62	45	46
No biopsy	45	38	55	54
	100	100	100	100

TABLE 16.—*Distribution of Biopsy at Operation According to Survival*

Survival Group	Biopsy (97), Percentage	No Biopsy (80), Percentage
Living and well	64	47
Died of intercurrent disease	13.5	20
Died of or living with recurrence	22.5	33

TABLE 17.—*Comparative Results, Expressed in Percentages, of Postoperative Roentgenotherapy*

Roentgen Therapy	Patients Living and Well	Patients Who Died of Intercurrent Disease	Patients Who Died or Were Living with Recurrence	Total
All Patients (177)				
Yes (116)	55%	15%	30%	100%
No (61)	50%	18%	23%	100%
Patients Without Axillary Involvement (103)				
Yes (59)	66%	12%	22%	100%
No (44)	70%	14%	16%	100%
Patients with Axillary Involvement (74)				
Yes (57)	44%	19%	37%	100%
No (17)	29%	29%	42%	100%

the breast and to proceed with radical mastectomy only after an immediate gross and microscopic diagnosis of malignancy by the hospital pathologist (tables 15 and 16). With that practice we frequently avoided unnecessary radical operations, but we also wondered uneasily whether the later course in cases in which the lesions proved malignant would be adversely affected. The completeness of our follow-up study and the fact that three fifths of the patients currently living and

apparently well had such biopsies, and represent numerically the largest single group in the series, make us feel that careful biopsies are at least not harmful, and we are currently continuing the practice.

INFLUENCE OF POSTOPERATIVE ROENTGENOTHERAPY

Comparison of the results for those of the 177 patients who had early postoperative roentgenotherapy with the results for those who did not is inconclusive as to any clearcut beneficial influence of such treatment on the prognosis. Table 17 indicates this. We do not wish to imply, however, that early postoperative roentgenotherapy is either harmful or of no possible value. Our patients to whom such treatment was given were not selected with sufficient consistency and impartiality to warrant conclusions, even had our figures seemed to show a trend in either direction. In the series of 177 patients, the proportion of women with axillary involvement who received roentgenotherapy was considerably larger than that of the women who were free from such metastases.

CONCLUSION

In conclusion, the close observation and study of our series of patients with cancer of the breast, and especially of those who survived operation five years or more has in every way strengthened our conviction that a thoroughly radical operation is the only procedure at present giving such patients a good chance of long survival. We believe that such an operation should be undertaken whenever it can be performed with technical adequacy unless coexisting metastases are so advanced or widespread and the patient's expectancy of life is clearly so short as to make operation futile.

340 Lakeland Avenue.

DISCUSSION

Dr. Willis D. Gatch, Indianapolis: Here is a study extending over thirty years, probably costing thousands of dollars, which is honest and of tremendous scientific value. I know of no such thorough study of the end results of the operative treatment of cancer of the breast. Dr. McGraw has traced 99 per cent of all patients.

The paper is so rich in facts that I cannot hope to discuss all of them. These results confirm the fact established by other studies that the modern operation for cancer of the breast gives about 40 per cent of five year survivals. Halsted had this percentage of survivals fifty years ago, and he operated, on the whole, on patients with more advanced cancer than those operated on today. I believe that any surgeon who reports a much higher survival rate than 40 to 45 per cent either is not following his patients carefully or must have a pathologist who is very free in his diagnosis of cancer. The last factor is an important one. The inexperienced pathologist is inclined to play safe, as they say, and make a diagnosis of cancer in doubtful cases.

Dr. McGraw states that his results do not prove that roentgen therapy has been beneficial. Roentgenologists state that about 12 per cent of cancers of the breast are radiosensitive and that 80 per cent are highly radioresistant.

Dr. McGraw has shown an important fact, namely, that the outlook of patients with metastasis to the axillary nodes is a good deal better than one has been led to expect in the past and that the outlook of patients who have no metastasis to the axillary nodes is a little worse.

Can one ever be sure that a woman has been cured of cancer of the breast? My answer is "No." I have observed recurrence after seventeen years. Dean Lewis reported the observance of abdominal metastasis at autopsy forty-three years after radical mastectomy. The clinical behavior of cancer of the breast is often difficult to understand. One of my patients remained free of metastasis and free of all signs of trouble for three years. Then, within a period of three weeks, dozens of metastases broke out in all parts of her body. What caused this cancer to remain quiet for three years and then suddenly become so extraordinarily active? Two factors must be involved. First, every one probably has more or less resistance to the spread of cancer. Second, and more important, the degree of malignancy of the cancer varies. Early operation is better than late operation, but not so much better as one has been led to think. Some growths are so malignant as to metastasize almost as soon as they appear. Can the results of surgical treatment be improved? We seem to have reached an impassable barrier. Whether or not castration of women who have cancer of the breast in the menstrual period of life will improve results remains to be seen. My faith in it is not great, though I have no objection to the treatment of such patients with androgens, as Dr. McGraw has done. I have never observed much difference in the clinical behavior of cancer of the breast before and after the menopause. It used to be thought that cancer of the breast was far more malignant in young women than in older ones, but one is no longer certain about this. In a study of this kind, it is well to consider what types of cancer should not be operated on at all. So-called inflammatory cancer should probably be considered inoperable, for even palliative operations are likely to make it worse. Harrington has pointed out that the behavior of "inflammatory cancer" is probably due to its site of origin on the under surface of the breast. This causes it to infiltrate widely into the deep lymphatic vessels before the patient realizes that anything has happened. It also causes widespread edema of the tissues, so that even the physician does not feel a discrete lump.

Examination of the specimen by the pathologist is often haphazard and unfit. This is especially true in regard to the discovery of cancerous lymph nodes in the axilla. Such nodes often cannot be felt in a fresh specimen. In a specimen fixed overnight in formaldehyde these are easily felt as shotty nodules.

Dr. Stuart W. Harrington, Rochester, Minn.: I congratulate Dr. McGraw on his excellent follow-up study of these patients with carcinoma of the breast. I know that this entails a tremendous amount of work. I am pleased that he has stressed the importance of early operation before axillary metastasis has occurred.

I have been interested for a number of years in the factors which influence the results of surgical treatment of carcinoma of the breast. I may mention some of the more important of these factors: (1) the extent of malignant involvement at the time of operation; (2) the thoroughness with which the radical operation is done; (3) the degree of malignancy, as shown by microscopic examination of the primary lesion; (4) the presence of associated conditions, such as

pregnancy; (5) general constitutional diseases, such as diabetes, and (6) the age of the patient.

Although metastasis to the axillary lymph nodes is only one of the factors which may indicate the extent of the disease at the time of operation, I believe that it is one of the most important indications of the prognosis after operation because of the great influence that it has on the rate of survival. I believe, therefore, that in compiling statistical studies of survival rates for malignant disease of the breast, all cases should be divided into two main groups, those with and those without metastasis to the axillary lymph nodes at the time of operation.

The grade of malignancy is important in prognosis, because the higher the grade of malignancy the greater the probability of metastasis to the axillary nodes. In the series of carcinoma of the breast at the Mayo Clinic, it was found that 49.2 per cent, or nearly one half of all carcinomas of the breast, were of grade 4 malignancy and that of the cases of grade 4 malignancy metastasis to the axillary nodes was present in 84.1 per cent at the time of the operation. When the lesions of grade 3 and grade 4 malignancy were combined, it was found that metastasis occurred early in 81.7 per cent of carcinoma of the breast. This observation, again, emphasizes the seriousness of malignant disease of the breast in that the majority of the lesions are of a high grade of malignancy and present a high percentage of metastasis to the axillary nodes at the time of operation.

The importance of the presence or absence of metastasis to the axillary nodes at the time of operation is shown in a study of 6,149 patients who had radical mastectomy, 60.5 per cent of whom had metastasis to the axillary nodes at the time of operation. Of the patients who did not have axillary metastasis at the time of operation, or 39.5 per cent of the entire series, the percentage who lived three years or more after operation was 85, a proportion almost twice as large as that of the group with axillary metastasis, which was 45.3 per cent. For the five, ten, fifteen and twenty year survival periods of patients without metastasis to the axillary nodes, it was found that the rates showed progressive improvement as compared with the rates for the group with axillary metastasis. For the five year period, the survival rate for the group without metastasis was 75.7 per cent, and that for the group with metastasis, 30.4 per cent; for the ten year period the survival rates for the group without and the group with axillary metastasis were 57.9 and 16.4 per cent, respectively; for the fifteen year period, they were 44 and 11.1 per cent, and for the twenty year period they were 33.5 and 6.5 per cent.

DR. ARTHUR B. MCGRAW, Grosse Pointe, Mich.: I wish, first, to clear a possible misunderstanding with regard to my statement about roentgen treatment after radical mastectomy: What I had to say dealt entirely with immediate or early postoperative treatment. My colleagues and I use and depend greatly on high voltage roentgen therapy in the care of patients in whom metastasis develops and who later die of the metastases.

You might be interested in the sources of our follow-up studies, that is, how we came by our information. Briefly, in order of the frequency, they were as follows: (1) patients who either were seen alive at the Henry Ford Hospital or died in the hospital, total 48 per cent of the patients followed in this report; (2) information by letter which we considered adequate, 22 per cent; (3) information by telephone (which we did not like to use but had to to some extent), 11 per cent; (4) The board of health, either of the city of Detroit or of other

communities, 10 per cent; (5) physicians, 5 per cent; (6) verbal report, only 4 per cent.

In determining the adequacy of this follow-up information, we rated what we secured ourselves, what we got through boards of health and what we got from physicians as dependably accurate. Such information totals 63 per cent. We consider letters and carefully conducted telephone conversations as reasonably good reports, and information from these sources totals 33 per cent. What we should regard as questionable information only comes to 4 per cent of our total follow-up data.

I wish to thank Dr. Gatch for his kind and interesting discussion. He went into a number of points that I should like to have mentioned, but which the time forbade. I am also grateful to Dr. Harrington for bringing the two interesting lantern slides and giving you the benefit of what I believe is an important factor in the matter of follow-up studies. Such surveys not only have to be pursued and continued but must be well planned, and in any hospital of five hundred beds or more there ought to be a department of biometrics and statistics, as there is in the Mayo Clinic. In such a department, studies are first planned, then data collected and finally assembled and sorted. The information that proves irrelevant can be picked out and set aside, and the relevant data can be put on record, accumulated and finally interpreted with regard to its statistical significance.

When that is done, as at the Mayo Clinic, one possesses, as you have seen in Dr. Harrington's lantern slides, a splendid résumé. What are those of us who have numerically smaller groups of cases going to do? One wonders whether an organization such as this association might not undertake some form of planned cooperative follow-up study among its members. Certain types of lesions or conditions in which we were interested could thereby be followed carefully and uniformly over a period of years. By combining a number of small groups of cases, a single, large group yielding statistically significant information would be secured.

AMEBIASIS WITH PULMONARY INVOLVEMENT

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ENDAMOEBA histolytica, first described by Losch in 1875, has been long established as the cause of tropical liver abscess. The specificity of emetine hydrochloride in the treatment of amebic infection was established by Vedder and by Rogers.[1] Recent articles by Ochsner and DeBakey,[2] Smith and Ruffin[3] and Klatskin[4] have reemphasized the value, first recognized by Rogers,[5] of emetine hydrochloride therapy in contrast to open operative drainage.

INCIDENCE

Endamoeba histolytica is probably harbored by between 10 and 20 per cent of the population, with twice this percentage in the returning soldiers from some areas. The incidence in these carriers of active dysentery is not accurately known. The incidence of hepatic involvement in cases of dysentery varies from 9 per cent in early, well treated clinical cases to 95 per cent in fatal cases. Pleural and pulmonary complications occur in from 5 to 15 per cent of cases of dysentery and in from 10 to 20 per cent of cases of hepatitis.

From the Thoracic Surgery Section, Kennedy Veterans Administration Hospital.

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PATHOLOGIC PROCESS

Through the portal vein the ameba reaches the liver, in which thrombosis and necrosis first occur in the finer radicles. The process may be arrested with fibrosis or may extend and coalesce to form a typical large solitary abscess of the right lobe of the liver, usually anteriorly and medially. The pleura and lungs usually become involved by direct extension through the diaphragm. A sterile empyema, with bloody or reddish brown fluid, follows pleural involvement. Bronchobiliary fistula without empyema or pneumonitis frequently occurs. More often diffuse pneumonitis of the lower lobe of the right lung occurs, followed by an abscess or a bronchopleural fistula.

CLINICAL PICTURE

The initial clinical picture before pulmonary involvement is usually that of acute amebic hepatitis with or without abscess formation. The patient appears acutely ill, with chills and fever, pain in the right upper abdominal quadrant often referred to the shoulder and an enlarged tender liver. Roentgenologic study reveals elevation, irregularity and fixation of the right side of the diaphragm.

Klatskin, in a series of 69 patients with hepatic disease, found that abnormal pulmonary physical symptoms were present in 16 and that while a primary diagnosis of pulmonary disease was made in only 16 per cent of the entire series it was made in one third of the cases in which there was acute hepatitis or hepatic abscess. In 17 of the 36 cases the roentgenograms showed abnormalities which were usually interpreted as those of early pneumonia. The pulmonary changes were considered as secondary to the involvement of the liver and were thought to be probably due to atelectasis.

When the pleura becomes involved, cough and pain in the chest, aggravated by deep breathing, and an associated pleural effusion make their appearance. Aspiration of the pleural effusion usually reveals a sterile bloody or reddish brown fluid, in which amebas may be found.

When the lungs become involved, the initial dry irritative cough quickly becomes productive of a bloody purulent sputum, in which amebas may also be found. Roentgenograms of the chest usually reveal a characteristic fixed elevated diaphragm, with a localized bulging and obliteration of the cardiophrenic and anterior costophrenic angles and a characteristic triangular shadow with the base toward the liver and the apex extending toward the hilus of the lung. Cavitation may be present. After the abscess ruptures into a bronchus, the resulting bronchohepatic fistula may be demonstrated with iodized oil U. S. P. When pulmonary and hepatic amebic disease remains undiagnosed for a period of time, the patient loses weight and becomes weak and anemic.

In patients with these symptoms there is commonly moderate leukocytosis, without much change in the proportion of polymorphonuclear leukocytes. The sedimentation rate is elevated. Eosinophilia is unusual.

DIAGNOSIS

The most important factor in making the diagnosis is to consider the possibility of amebic infection. An infection with ameba should always be considered a possibility in a patient presenting an acute febrile illness with symptoms in the chest when the lesion involves the lower lobe of the right lung or the right region of the diaphragm or when a bloody pleural effusion is present.

A presumptive diagnosis can be made when there is an associated enlarged tender liver, a fixed elevated diaphragm and characteristic roentgenologic findings.

A positive diagnosis is reached by the characteristic response to emetine hydrochloride or by the finding of the causative organism, E. histolytica, in the sputum or aspirated fluid. A history of or the presence of dysentery is not essential to the diagnosis.

Diagnoses which are most commonly made when a patient has pleuropulmonary amebiasis are basal tuberculosis, a pyogenic abscess of the lung, carcinoma of the lung or liver, pyogenic subphrenic abscess, perinephritic abscess, pyogenic empyema, malaria, typhoid and dengue fever.

TREATMENT

The specific therapy for amebic hepatic and pleuropulmonary involvement is emetine hydrochloride given subcutaneously. The usually recommended dosage is 0.5 grain (0.03 Gm.) twice a day or 1 grain (0.06 Gm.) daily for six to ten days. Before the institution of this treatment, the patient should have thorough cardiovascular studies, including an electrocardiogram, since the drug is primarily a protoplasmic poison that first affects the myocardium. Toxicity is shown by lowering of the blood pressure and cardiac irregularity. An adequate diet of proteins, carbohydrates and vitamins is indicated.

A full course of emetine hydrochloride is given in the presence of an abscess before other measures are considered except when the abscess threatens rupture as shown by an increase in size. Aspiration of such an abscess by the method of Ochsner and DeBakey should be undertaken soon but preferably after two to four days of emetine hydrochloride therapy.

Klatskin has successfully treated several patients with hepatic abscess with emetine hydrochloride therapy alone. His criteria for cure are (1) complete absence of pain and fever, (2) absence of enlargement of the liver, (3) absence of subcostal and compression tenderness and

(4) a normal white blood cell count and sedimentation rate. To achieve these results the dosage must be adequate, and an initial course of 12 grains (0.78 Gm.) is given. If necessary, subsequent courses of 1 grain (0.06 Gm.) daily for six days are given, with two week periods of rest between courses. The maximum dose required in any of his cases was 27 grains (1.75 Gm.).

In addition to emetine hydrochloride, the use of either diodoquin or chiniofon is advisable. In the presence of hepatic disease the arsenical amebacides such as carbarsone probably should not be used, but no known harm resulted from the use of this in the 3 cases reported here.

Open drainage of amebic abscess is contraindicated, since Ochsner and DeBakey have shown that open drainage without the use of emetine

Fig. 1 (case 1).—Roentgenogram shows the area of pneumonitis in the lower part of the right lung before treatment.

hydrochloride gives a mortality rate of 48.2 per cent, that open drainage with emetine hydrochloride gives a mortality rate of 15.3 per cent and that with emetine hydrochloride therapy alone the mortality rate is only 5.5 per cent. Exceptions to this general rule should probably be made in the presence of abscesses secondarily infected from bronchial involvement and other causes which have not responded to treatment with emetine hydrochloride, penicillin and the sulfonamide compounds.

Rogers stated that when emetine hydrochloride fails in superficially located abscesses of the left lobe of the liver surgical drainage is indicated since aspiration in these cases has proved hazardous.

An amebic abscess of the lung should first be treated with emetine hydrochloride and penicillin or sulfadiazine. Usually the involvement clears with a minimal scarring. If cavitation persists or extends after

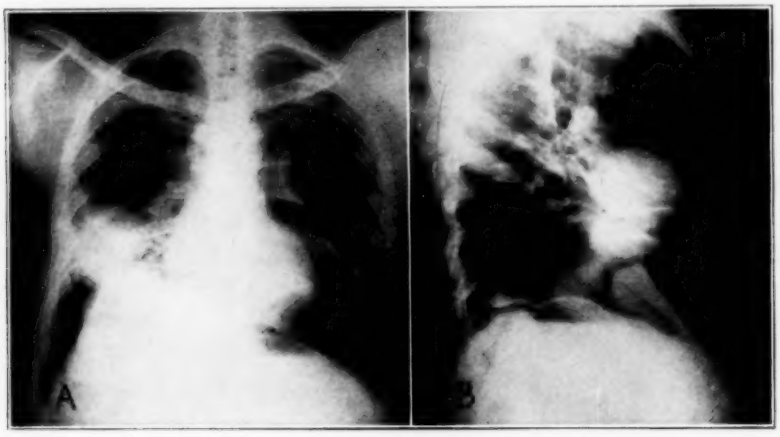

Fig. 2 (case 1).—Roentgenogram of the same patient after pneumoperitoneum, showing adhesions between the liver and the diaphragm at the site of the pulmonary infiltration.

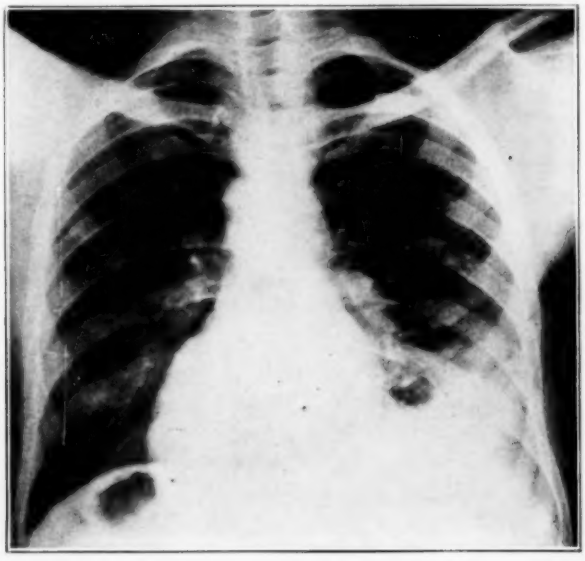

Fig. 3 (case 1).—Immediate clearing of the pneumonitis after treatment with emetine hydrochloride daily for ten days.

treatment, drainage is probably indicated. We have had no experience of nor have we found any reference in the literature to persistent cavitation of the lung due to the Endamoeba after adequate treatment with

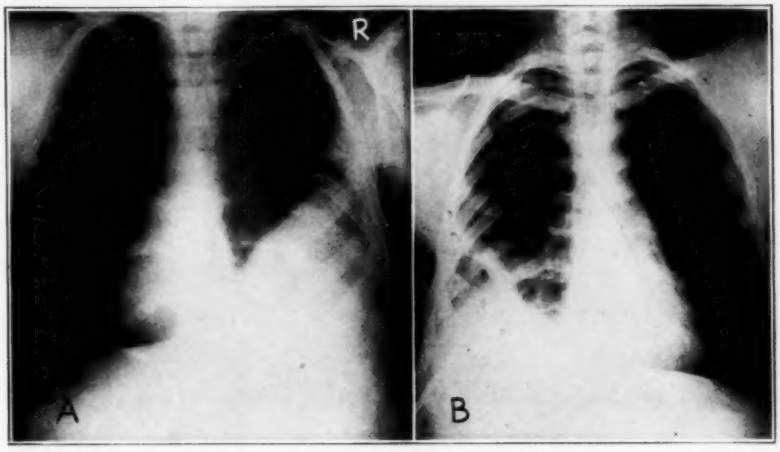

Fig. 4 (case 2).—*A*, roentgenogram of the chest on admission of the patient to the hospital with involvement of the lower part of the right lung. A bronchopleural fistula was present. *B*, the closed intercostal drainage tube in place, with clearing of the process.

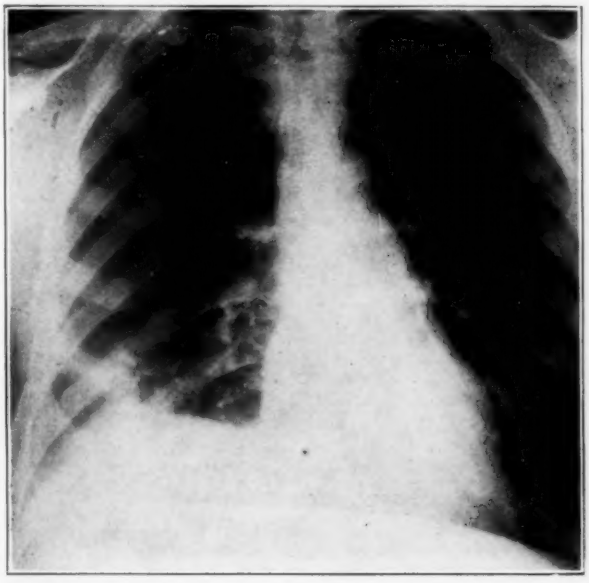

Fig. 5 (case 2).—Residual scarring remaining after the use of emetine hydrochloride and closed drainage.

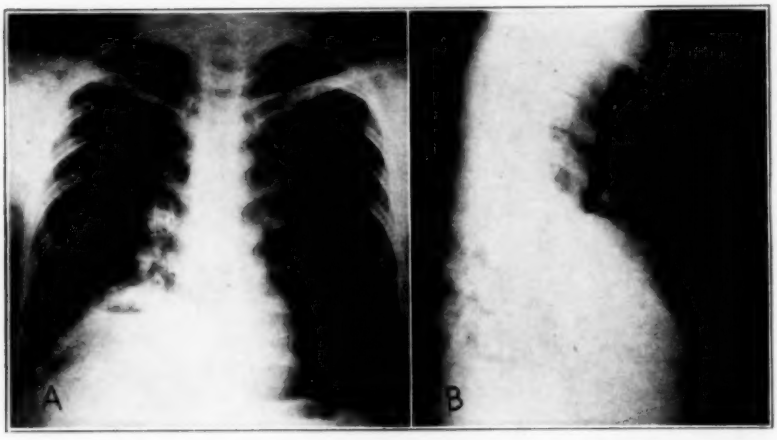

Fig. 6 (case 3).—*A*, roentgenogram of the chest on admission of the patient to another hospital showing an amebic abscess of the lower part of the right lung. *B*, lateral view a few days later, with pneumonic involvement of the lower lobe.

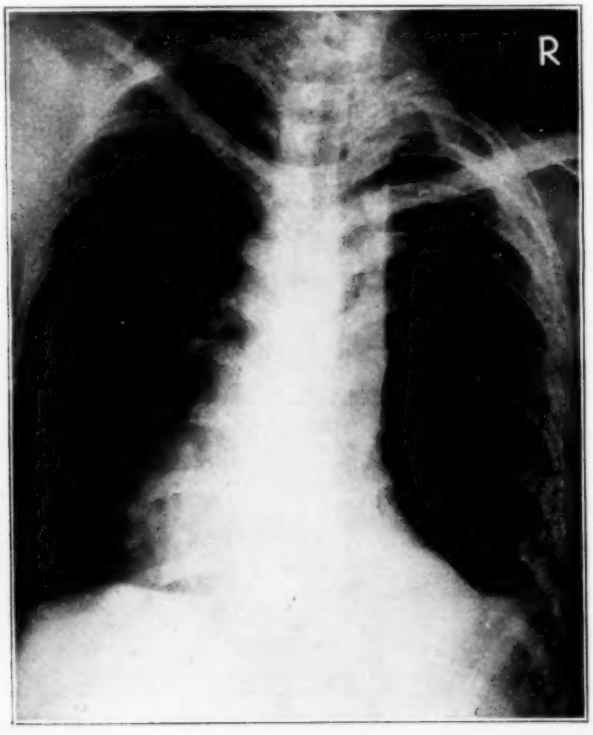

Fig. 7 (case 3).—The condition of the chest twenty-nine days after admission of the patient to Kennedy Veterans Administration Hospital. The patient on admission was toxic, had an open thoracotomy tube, a total empyema and a bronchopleural fistula.

emetine hydrochloride, but we feel that cases in which this occurs should be studied and the treatment should be the same as that in any undiagnosed cavitation of the lung.

Of our 2 patients at the Kennedy General Hospital and 1 at the Kennedy Veterans Hospital, 2 had empyema complicated by bronchopleural fistulas. One patient was treated with emetine hydrochloride, intercostal drainage and penicillin and recovered with a minimum amount of residual scarring of the lung. In the other a complete empyema, with a large bronchopleural fistula developed after open thoracotomy at another hospital. This patient was treated with emetine hydrochloride, closed intercostal drainage and decortication of the lung. More details of the 3 cases follow.

REPORT OF CASES

CASE 1 (figs. 1 to 3).—In a 25 year old Negro cough, fever and pain in the right side of the chest developed in August 1944 while he was a patient at another hospital. A roentgenogram on September 26 revealed fixation of the right side of the diaphragm and an opacity in the lower lobe of the right lung. On October 18 he was admitted to Kennedy General Hospital. Bronchoscopy and a bronchogram were noncontributory. Pneumoperitoneum (fig. 2) revealed adhesions between the liver and the diaphragm at the site of the pulmonary infiltration, and E. histolytica was found in the stools. Emetine hydrochloride, 1 grain (0.06 Gm.) subcutaneously, was given daily from November 11 to 21. The fairly pronounced clearing of the infiltration with descent of the diaphragm is shown in figure 3. A course of 120 grains (7.7 Gm.) of chiniofon and 8 grains (0.52 Gm.) of carbarsone was given before discharge of the patient from the hospital. On Jan. 13, 1945, only a slight element of fibrosis with obliteration of the costophrenic angle, was present in the roentgenogram of the chest. The patient was discharged from the Army with a diagnosis of unqualified constitutional psychopathic state.

CASE 2 (figs. 4 and 5).—Pain in the right lower part of the chest, nausea and vomiting, with weakness and loss of weight, developed in a 24 year old white man in May 1944. On June 24 his temperature was 103 F. and he had a large tender liver. The roentgenogram of his chest is shown in figure 4 *A*. Six days later, thoracentesis yielded reddish brown pus. With the development of a bronchopleural fistula, he suddenly expectorated large quantities of bloody pus.

He was admitted to Kennedy General Hospital on Sept. 7, 1944, acutely ill and unable to lie flat in bed. Amebas were found in the pleural fluid at the time the intercostal closed drainage was instituted. Treatment with emetine hydrochloride was started the same day. Figure 4 *B* shows the condition a few days later.

Two courses of emetine hydrochloride, carbarsone and vioform were given, and he was discharged sixty days after admission. He had gained 60 pounds (27 Kg.) in weight while in the hospital. Figure 5 shows the residual fibrosis at this time.

CASE 3 (figs. 6 to 9).—A 21 year old white man became sick in May 1946 with pain in the right side of the chest and in the right shoulder, fever and weakness. Three weeks later a cough developed, with bloody purulent sputum. He was admitted to a hospital on June 11, 1946, with these symptoms and the demonstration

of a cavity and other typical findings in the roentgenogram (fig. 6). The red blood cell count was 3,700,000, the hemoglobin content 75 per cent and the white blood cell count 10,800, with 78 per cent polymorphonuclear cells and 1 per cent eosinophils. Sterile bloody pleural fluid was aspirated two weeks after the patient's admission to the hospital. A month after admission, a thoracotomy was performed. Bloody fluid was found in large quantity. After this the pleural space was irrigated with chlorazodin or acriflavine or buffered aqueous solution of sodium

Fig. 8.—The graphic chart during the first month at Kennedy Veterans Admin- is shown. The change in the clinical condition was even more striking.

hypochlorite, and he was given penicillin and sulfonamide compounds, all without effect. On July 22, the right lung was collapsed; his red blood cell count was 2,500,000, and his hemoglobin content 50 per cent.

He was transferred to Kennedy Veterans Hospital on Aug. 8, 1946, with the thoracotomy wound, empyema and bronchopleural fistula. There was tenderness in the right upper abdominal quadrant, and he had a daily temperature of up to 103 F. Culture of the fluid from the chest showed the presence of Proteus,

aerogenes, paracolon bacillus, Bacillus pyocyaneus, Streptococcus and Staphylococcus. A Stedman pump was used to obtain suction through a large intercostal tube.

The space was almost obliterated by displacement of the thoracic contents by August 17, but there was poor aeration of the lung, and the displacement could not be maintained (fig. 6 *B*). Bronchoscopic examination showed no pus, but a foul odor was present. The septic condition continued, and the serum albumin content

istration Hospital. The dramatic effect of emetine hydrochloride on the temperature

dropped to 2.5 Gm. in spite of frequent blood transfusion and the intravenous administration of amigen. E. histolytica was found in the pleural pus on August 21. Therapy with emetine hydrochloride and carbarsone was begun on the same day and was later followed by the administration of diodoquin.

The graphic chart (fig. 8) shows the immediate response. By September 23 he had gained 10 pounds (4.5 Kg.) in weight on a diet high in carbohydrate and protein. He had no fever for the first time in three months and the red blood

cell count was 4,500,000, the white blood cell count 13,000, the hemoglobin content 14.5 Gm. per hundred cubic centimeters, the protein level and the albumin level 4.5 Gm.

Because of the persistent total collapse of the lung and the fistula, decortication and closure of the bronchopleural fistula with resection of a small portion of the lower lobe were done on September 24.

The fistula recurred, and the lung failed to expand completely. On November 7 a second decortication and closure of the fistula were done. The fistula remained closed; the condition on December 2, with the patient still under treatment, is shown in figure 9.

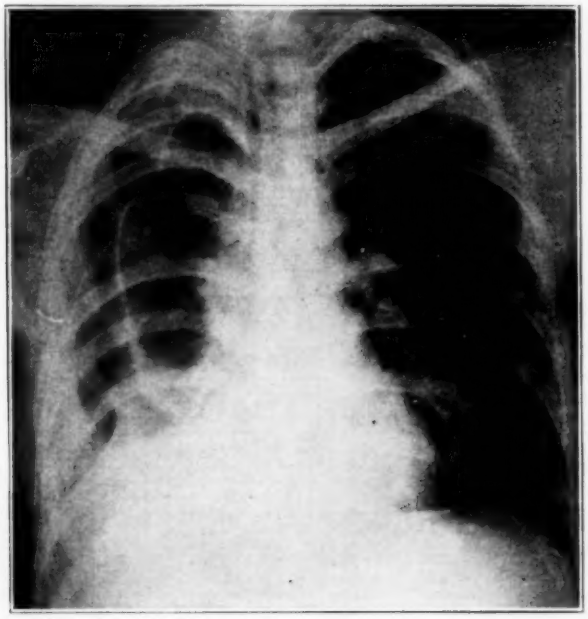

Fig. 9 (case 3).—Partially expanded lung after the first decortication. The bronchopleural fistula recurred.

SUMMARY

1. Three cases of amebic infection of the lung are reported.

2. The incidence of amebic infection in the United States is far more common than is realized.

3. Amebic hepatopulmonary disease occurs often enough to be included routinely in the differential diagnosis of diseases of the right upper abdominal quadrant or right lower part of the chest.

4. The diagnosis is made by the finding of Endamoeba histolytica or by the specific response to emetine hydrochloride.

5. Amebic infection of the liver and lung did not respond to any therapy until emetine hydrochloride was used.

6. Surgical procedures, apart from aspiration, are not indicated except for complications such as a total empyema or bronchopleural fistula.

7. Of our 3 patients, 1 responded to emetine hydrochloride, the second was cured by the administration of emetine hydrochloride and by closed drainage of an empyema and the third, in whom the condition was complicated by prior surgical treatment, required emetine hydrochloride and decortication.

TRAUMATIC BILIARY-BRONCHIAL FISTULA

With Report of Two Cases Due to War Wounds

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A BILIARY-BRONCHIAL fistula results from some disease or injury which establishes a communication between portions of the biliary and bronchial trees. Although of infrequent occurrence, such fistulas resulting from infection and abscess formation have long been recognized.[1] The most common immediate cause is infection of the subphrenic space, since this location is in close proximity to both biliary and bronchial tracts. If such infections spread upward via the lymphatic vessels through the diaphragm they may invade adherent lung tissue and eventually drain spontaneously through a bronchus. Bronchial fistulas are reported to occur in about 10 to 12 per cent of all cases of subphrenic abscess.[2] Similarly, suppurative lesions of the liver may drain via a bronchus after becoming adherent to the diaphragm in the absence of a true subphrenic abscess. Amebic abscesses and echinococcic cysts of the liver, especially when secondarily infected, may thus eventuate in a bronchial fistula. These two diseases appear to be the commonest causes of biliary-bronchial fistula,[3] although Burgess[4] and McNee[5] believe the majority are due to suppurative processes in the biliary tract secondary to cholelithiasis. Blockade of the common duct from a variety of other causes, such as neoplasms, surgical trauma,

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From the Department of Surgery, University of Illinois College of Medicine.

1. Graham, J. E.: Observations on Broncho-Biliary Fistula with Reports of Two Cases, Brit. M. J. **1**:1397-1400, 1897.

2. Ochsner, A., and De Bakey, M.: Subphrenic Abscess: Collected Review and Analysis of 3,608 Collected and Personal Cases, Internat. Abstr. Surg. **66**: 426-438, 1938; in Surg., Gynec. & Obst., May 1938. Head, J., and Hudson, T. R.: Subphrenic Abscess with Bronchial Fistula, ibid. **75**:54-60 (July) 1942.

3. (*a*) Morton, J. J., and Phillips, E. W.: Broncho-Biliary Fistula: Review of Recorded Cases Other than Those Due to Echinococcus and Amebic Abscess, Arch. Surg. **16**: 697-754 (March) 1928. (*b*) French, R. W.: Bilio-Bronchial Fistula, ibid. **30**: 635-638 (April) 1935.

4. Burgess, A. H.: Bronchobiliary Fistula, Brit. J. Surg. **9**:253-255 (Oct.) 1921.

5. Rolleston, H. D., and McNee, J. W.: Diseases of Liver, Gallbladder and Bile Ducts, ed. 3, London, Macmillan & Company, Ltd., 1929.

tuberculosis, gumma and parasites, may result in hydrohepatosis. Secondary or associated infection may then lead to involvement of the subphrenic space and an eventual fistula through the diaphragm and a bronchus. The blocked and dilated bile ducts thus offer an obvious explanation for the continuous expectoration of bile. One such fistula [6] persisted for nine years. The essential pathologic changes necessary for the establishment of a biliary-bronchial fistula are therefore to be found below the diaphragm and consist of a lesion in either the liver parenchyma or the extrahepatic bile passages. The resulting sputum may contain bile mixed with other contents of a cavity, including purulent material, blood and necrotic liver tissue. Even biliary calculi have been reported in the sputum.[1] The term, bronchobiliary fistula, as found in the older literature,[7] is a misnomer, inasmuch as suppurative processes above the diaphragm rarely, if ever, extend downward into the liver, the lymphatic flow being in the opposite direction.

In 1928 Morton and Phillips [3a] reported a case and made a comprehensive survey of the literature on biliary-bronchial fistula. They recorded a total of 50 cases exclusive of those known to be due to amebic or echinococcic liver disease. In 1935 French [3b] added to this collection. Since that time, several others [8] have been reported which, with the 2 cases herewith described, brings the total to 64. It is obvious that such fistulas are uncommon complications of nonparasitic liver disease. They are even less common as a result of trauma. Of these 64 cases, only 6, including the 2 we describe, have resulted directly from external violence or wounds. Our purpose is to review these 6 cases and to advance certain observations regarding pathology and treatment.

REPORT OF CASES

CASE 1.—*History.*—Pfc. G. R. P., white, American, aged 28, was wounded by a rifle bullet while on guard duty in France on July 9, 1944. The bullet entered the right anterior wall of the chest 2 inches (5 cm.) medial to the nipple at the level of the fifth rib and emerged posteriorly in the midscapular line over the tenth rib. Ten hours later thoracotomy was performed at an evacuation hospital. Portions of the tenth and eleventh ribs were resected and the pleural cavity

6. Robson, A. W. M.: Biliary Pulmonary Fistula Cured by Hepatodochotomy, Practitioner **75**:12-15, 1905.

7. Graham.[1] Morton and Phillips.[3a] Seelig, M. G., and Singer, J. J.: Bronchobiliary Fistula, Arch. Surg. **19**:149-151 (July) 1929.

8. (*a*) Sugimura, Y.: Biliary-Bronchial Fistula, Ztschr. d. japan. chir. Gesellsch. **36**:45-47, 1935. (*b*) Matrosov, S. A.: Biliobronchial Fistula, Vestnik khir. **43**:100-103, 1936. (*c*) Martsinkovskiy, B. I.: Problem of Biliobronchial Fistula and Fermentative Capacity of the Liver, Klin. med. **16**:23-27, 1938. (*d*) Miller, I. D.: Broncho-Biliary Fistula Following Stenosis of Common Bile Duct, Brit. J. Surg. **27**:425-426 (Oct.) 1939. (*e*) Piccinini, P.: Bilio-Bronchial Fistula: Clinical and Roentgenological Study of Case, Ann. ital. di chir. **19**: 589-606 (July-Aug.) 1940.

explored. Severe lacerations were sutured in the right lower pulmonary lobe and diaphragm. The chest was closed tightly and catheter drainage of the pleural cavity instituted through a counterincision. Following the operation his condition was fair, although he was dyspneic, with a sharp hacking cough productive of blood-streaked sputum. Three days after thoracotomy, aspiration of the right pleural cavity yielded 300 cc. of bloody fluid and air. Roentgenograms on July 15 showed pneumothorax with fluid and about 10 per cent collapse of the right lung.

On July 18, nine days after being wounded, he first noticed a bitter tasting sputum, slight in amount at first, but increasing daily thereafter.

On July 23 he was transferred to the 297th General Hospital and was first seen by us. He complained of pain in the lower part of the right side of the chest and the upper abdominal area. He was dyspneic, with an irritating, persistent cough productive of a yellow bitter, blood-streaked sputum. He appeared anemic. Respirations were increased in rate and shallow. The lower part of the right side of the chest was dull to percussion, and the breath sounds were absent. The thoracotomy wound was unhealed and gaping in the posterior portion. The abdomen was soft but definitely tender over the area of the liver. The blood pressure was 108 systolic and 68 diastolic, the temperature 102.2 F., respirations 28 and pulse rate 104. Laboratory findings included: red blood cells 3,210,000, white blood cells 20,040, hemoglobin 70 per cent. Urinalysis gave normal results. Examinations of the sputum was reported as yielding negative results with the tests for bile usually made on specimens of urine. Roentgen examination (fig. 1) was reported by Lieut. Col. Elbert K. Lewis as showing fluid in the right pleural cavity with 20 per cent compression of the lung. There was marked elevation of the right side of the diaphragm. The shadow of the liver was altered by an area of decreased density suggesting a tissue defect. A cloudy, serous fluid, 150 cc., was aspirated from the right side of the chest and a blood transfusion was given. The future course of this patient by dates was as follows:

Treatment and Course.—July 26: He appeared improved. The cough was decreasing in frequency, but he was expectorating 4 to 6 ounces (118 to 178 cc.) of yellow bitter mucoid sputum every twenty-four hours.

August 3: The patient had improved in the last eight days. About 4 ounces of sputum was generally raised per day, in one or two coughing spells. The temperature was 99.4 F., the pulse rate 108 and the respirations 22. The character of the sputum had suddenly changed to thin, yellow fluid resembling almost pure bile. Few blood streaks were present in it. The amount of sputum had increased to 8 ounces (236 cc.) daily. Later in the day the patient complained of a burning sensation in the right side of the chest and had frank hemoptysis of about 80 cc. of bright red blood.

August 4: Phrenic nerve crush was performed under local anesthesia through a right supraclavicular incision. This was decided on because of doubt as to whether the lung or the liver was the source of bleeding.

August 6: The patient's condition was greatly improved The cough was decreased and he raised only about 2 ounces (60 cc.) in twenty-four hours; it was mucoid in character with few blood streaks and no gross evidence of bile. The patient was afebrile and pain was minimal

August 8: He had a severe coughing spell with hemoptysis of 500 cc. of blood, followed by a prolonged chill and a temperature of 104. Transfusions of whole blood and dextrose were given. Artificial pneumothorax was attempted, but was unsuccessful No conclusion was reached as to the source of the hemor-

rhage, but it was believed to be probably of hepatic origin. At one time the patient complained of pain and tenderness in the lower right quadrant of the abdomen, and there was some rigidity suggesting the possibility of biliary leakage into the peritoneal cavity. These symptoms subsided in twenty-four hours.

August 9: Repeated and more severe hemoptysis of 900 cc of blood occurred. Transfusions of whole blood were given. The patient's condition was serious Physical findings were about the same, although there was less clinical and roentgen evidence of fluid in the right side of the chest. Abdominal tenderness over the hepatic area was more marked. It was now felt that the limit of conservative treatment had probably already been overstretched and that death from

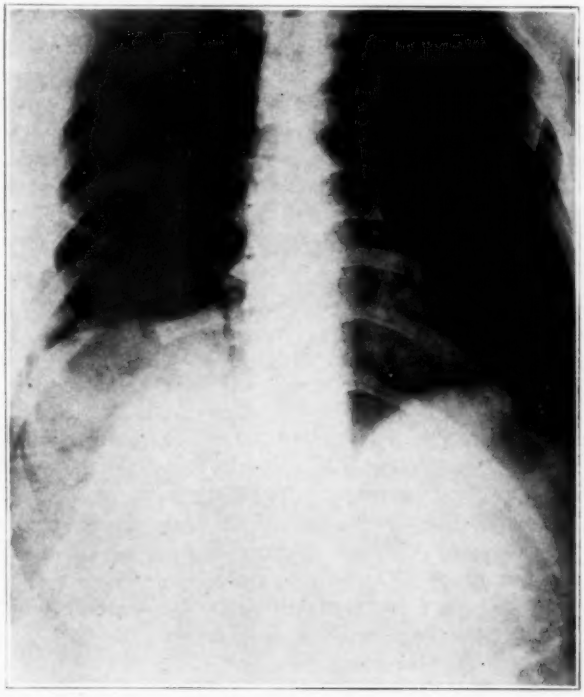

Fig. 1 (case 1).—Roentgenogram taken July 24 shows 20 per cent pneumothorax with fluid and partial resection of right tenth and eleventh ribs. Decrease in density in the liver shadow was proved at operation to be a large necrotic cavity, due to trauma by bullet. Tract of bullet shown by irregular line extending downward and laterally in the liver shadow.

exsanguination was imminent unless the hemorrhage could be checked by surgical means.

August 10: Operation was performed for bleeding biliary-bronchial fistula. Capt. E. R. Donahue induced intratracheal nitrous oxide-oxygen-ether anesthesia but only with great difficulty because of the poor condition of the patient and the constant bleeding into the bronchial tree. The right pleural cavity was entered through a posterolateral thoracotomy incision with removal of about 10 inches (25 cm.) of the ninth rib. The lower pulmonary lobe was carefully freed of semifirm adhesions between it and the wall of the chest and diaphragm. Adhesions were particularly

firm around a defect in the lateral medial portion of the diaphragm measuring about 3½ by 1½ inches (9 by 4 cm.) in size. Through this defect the fingers could be inserted into a large cavity at least 4 inches (10 cm.) in diameter in the right lobe of the liver. The subdiaphragmatic space appeared well walled off by adhesions. The cavity was filled with necrotic yellow-brown hepatic tissue and blood clots old and recent, and bleeding was constant from it. A fist-sized mass of blood clots and necrotic tissue were easily scooped from this cavity, but the bleeding from it became so alarming that no attempt was made to empty it completely. On the diaphragmatic surface of the lung there was a necrotic depression approximately 2 inches (5 cm.) in diameter and 1 inch (2.5 cm.) deep. An open bronchus about 6 mm. in diameter was clearly visible in the wall of this cavity. A wedge-shaped segment of lung including the cavity was resected and the defect closed with black silk sutures. The bronchial opening was closed by separate sutures. Bleeding from the liver was controlled by firm packing with about 12 yards of 3 inch (7.5 cm.) dry bandage gauze. The thoracotomy wound was closed at both ends, leaving the center open for access to the liver cavity and for drainage. Extensive pleural adhesions made any marked pulmonary collapse unlikely. The patient's immediate postoperative condition was extremely poor although blood transfusion was continued during and after operation.

August 11 (second postoperative day): The patient was coughing moderately and raised blood-streaked sputum. No bile was visible in the sputum, and its bitter taste was gone. The dressings were saturated with a copious bloody yellow discharge.

August 16 (seventh postoperative day): The packing in the liver had not been disturbed. On this day a sudden hemorrhage of about 500 cc. of blood occurred from the incision in the chest. The packing in the liver was reenforced, and a tight surface dressing was applied. The temperature was 101.6 F., the pulse rate 130 and the respirations 28. Cough was slight. The main complaint was pain in the upper right quadrant of the abdomen.

August 21 (twelfth postoperative day): All packing was removed. Through the thoracotomy one could look directly through the hole in the diaphragm into a portion of the liver cavity. The portion visible appeared to be lined by healthy granulation tissue, and there was no fresh bleeding. A sterile tray, with gloves, long forceps, gauze pack and dressings, was kept at the patient's bedside, and this was found to be a valuable forethought.

August 22: A sudden severe hemorrhage occurred from the liver, with a loss of an estimated 1,000 cc. of blood. Also extruded was a large soft brown mass of necrotic liver tissue, 10 by 3 by 2 cm. in size. The hemorrhage was promptly checked by rapid repacking with many yards of 4 inch gauze. During each of these repacking procedures the patient complained of only a moderate amount of pain, controllable by morphine.

August 28: For a week the patient had been comfortable, eating well and with no cough. Much clear bile still stained the dressings. On this date a third hemorrhage of approximately 1,000 cc. occurred suddenly. The old pack was removed and another inserted. It was noted that the liver cavity appeared 50 to 60 per cent smaller than at the operation, and the defect in the diaphragm was also greatly reduced in size.

September 6: Most of the packing had been extruded into the pleural cavity. All of it was removed. The defect in the diaphragm and liver now appeared as a shallow ulcer. The discharge was reduced in amount, and there was no fresh bleeding.

October 10: By this date all drainage had ceased, and the thoracotomy wound was healed; the patient felt well and was up and about (fig. 2).

November 22: The roentgenogram (fig. 3) shows complete reexpansion of the right lung and healing of the liver defect. The patient was transferred in excellent condition to the United States. Two months later he wrote that he felt well and was able to do heavy work.

Other Therapy: During treatment the patient was also given the following medicaments, whole blood and plasma:

Penicillin, total amount	1,890,000 units
Sulfadiazine, total amount	42 Gm.
Whole blood, total amount	7,650 cc.
Plasma, total amount	3,000 cc.

Summary.—The patient had a thoracoabdominal perforating bullet wound on the right side. After nine days a biliary-bronchial fistula developed. After twenty-four days he began to have severe hemoptysis. After thirty-one days the biliary-bronchial fistula was excised through a transthoracic approach, and a bleeding necrotic cavity in the liver was treated by repeated packing. Full recovery occurred.

CASE 2.—*History.*—Pvt. M. S., aged 25, suffered a perforating bullet wound of the upper part of the left arm on July 4, 1944. About one hour later he was again wounded by a mortar shell fragment which entered the anterior part of the right side of the chest at the level of the second rib in the midclavicular line. Examination later showed this fragment to have passed through the right lung and diaphragm and lodged in the liver. After four hours the patient reached an aid station, where his wounds were dressed and plasma administered. On July 5 at an evacuation hospital the wounds were debrided and 600 cc. of blood aspirated from the right pleural cavity. On July 14 he was transferred to a general hospital, where the right side of the chest was aspirated of 400, 500 and 540 cc. of blood on the following three successive days. He was dyspneic and had continued to have a low grade fever since July 5. He also complained of severe pain in the upper part of the left arm, and there was evidence of a lesion of the median nerve, for treatment of which he was transferred to a neurosurgical hospital.

Treatment and Course.—On July 21 he was admitted to the 55th General Hospital on the surgical service of Lieut. Col. Joseph Roberts. At a later date, one of us (E. T. O.) saw this patient, and Colonel Roberts gave us permission to report the case. A diagnosis was made of severe causalgia of the left median nerve, and this was relieved by blocking of the stellate ganglion.

On July 26 sympathectomy was performed on the second and third dorsal ganglions after excision of a portion of the fourth rib. Exploration of the ulnar and median nerves of the upper part of the left arm was done on August 7. From July 21 to August 19 the symptoms in the chest were quiescent, but on the latter date, forty-five days after wounding, he complained of pain and tenderness in the right upper quadrant of the abdomen, and his temperature rose to 101. A roentgenogram (fig. 4) taken on August 22 showed the right side of the chest apparently clear, but an area of decreased density with a fluid level was noted below the diaphragm. This appeared to be well above the foreign body and was interpreted as evidence of a gas-containing intrahepatic abscess. Penicillin and sulfanilamide therapy was started, but his condition grew worse.

At operation, August 22, the right anterior subphrenic space was opened through a small subcostal incision, and about 600 cc. of bile-stained purulent material

Fig. 2 (case 1).—Drawing made September 10, thirty days after repair of biliary-bronchial fistula and packing of bleeding necrotic cavity in liver. Scarring of the right posterolateral wall of the chest due to bullet wound and two thoracotomy incisions. A small central opening persists in the second incision.

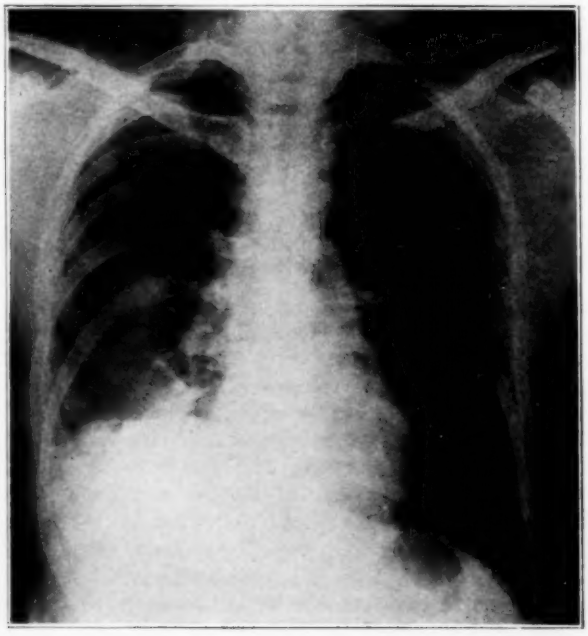

Fig. 3 (case 1).—Roentgenogram taken November 22 shows resection of the ninth rib at the second operation, complete reexpansion of the right lung and irregularity of the right side of the diaphragm. The previous defect in the liver is not visible.

was evacuated. A 22 F. catheter was inserted for drainage. During the following week the patient was much improved and the temperature was normal. The drain was removed on August 30. On September 4 the temperature again rose and on September 7 the patient suddenly coughed up about 500 cc. of foul-smelling, bile-stained purulent material. This was the first evidence of a biliary-bronchial fistula and appeared sixty-four days after the thoracoabdominal shrapnel wound. The cough persisted, with bile-stained sputum, and was very irritating. The patient complained of the bitter taste of the sputum. On September 8 the old incision was reopened and from the subphrenic space again drained a small amount of mixed pus and bile. For the next eleven days the patient continued to have a distressing cough productive of small amounts of bile-stained purulent sputum. A low grade fever persisted, and his condition gradually grew worse.

On September 19 a third operation was performed. Through a right rectus incision the anterior subphrenic space was more thoroughly explored, and an abscess cavity measuring 3 by 2 inches in size was found in the liver. A 2 by 1 cm.

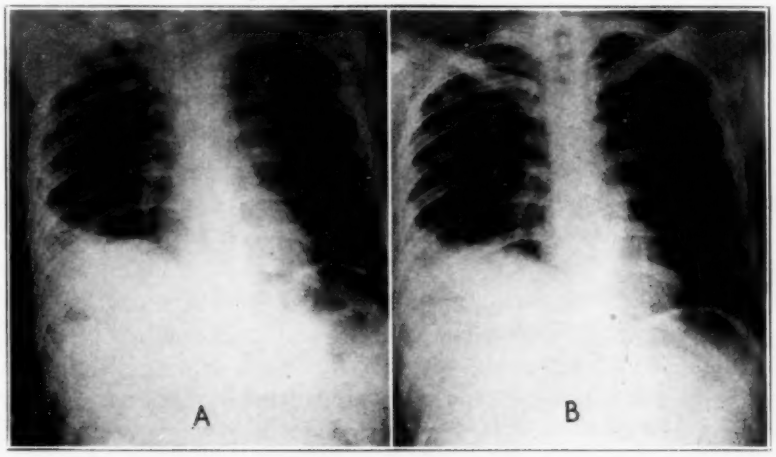

Fig. 4 (case 2).—*A*, a roentgenogram was taken on August 22, forty-eight days after the patient received a thoraco-abdominal wound on the right side. A foreign body is visible in the liver. The cavity with fluid level interpreted as intrahepatic. Partial excision of the left fourth rib was performed for sympathectomy, to relieve causalgia of the median nerve following bullet wound in the left upper arm. *B*, a roentgenogram was taken on October 9, ninety-five days after wounding of the patient. A cavity is still visible in the liver area. There are evidences of scarring in the right lower pulmonary lobe, of diaphragmatic pleural adhesions and of fluid in right pleural cavity. The biliary bronchial fistula had closed spontaneously by this date, after drainage of the subphrenic space and liver abscess, and removal of the foreign body.

metallic foreign body was removed from the cavity and cigaret drains inserted through the incision, which was then closed around the drains. The patient's cough markedly decreased, as did the amount of sputum. By October 7 cough and expectoration had completely ceased. The biliary-bronchial fistula had closed spontaneously after persisting for thirty days. A roentgenogram (fig. 5) taken on October 9 revealed more definite evidence of a pathologic process in the chest with a cloudiness in the right lower pulmonary field. A wedge-shaped shadow resembling pleural adhesions extended upward from the inner aspect of the dome

of the diaphragm. The gas-containing cavity was still visible. At this time there was another rise in temperature, to 102 F., with clinical evidence of fluid in the right pleural cavity. Aspiration of the chest was not done. On October 11 the subphrenic space was again opened through the rectus incision. A moderate amount of pus was evacuated, a large catheter was introduced for drainage, and the incision was only partially closed. Daily saline irrigations were introduced through the catheter.

By November 1 the patient had been afebrile for two weeks, had gained 15 pounds (6.8 Kg.) in weight and felt well. His further progress toward recovery was uneventful.

Summary.—The patient had a thoracoabdominal shrapnel wound on the right side, with hemothorax and a metallic foreign body in the liver. After forty-six days there was evidence of liver abscess. After sixty-four days a biliary-bronchial fistula occurred. In ninety-four days the fistula had closed, after four operations for drainage of abscess of the subphrenic space and liver and removal of an intrahepatic foreign body. The patient recovered.

REVIEW OF THE LITERATURE

Graham [1] in 1897 reported the case of a man in whom the right anterior wall of the chest was injured when kicked by a horse. Seventeen days later he coughed up bile, but there was no expectoration of blood. Two operations were performed for drainage of the right pleural cavity, which contained bile, but no mention is made of treatment directed toward the biliary-bronchial fistula. The patient made a slow recovery.

Tyrman [9] in 1909 cited a case due to a gunshot wound. The missile entered in the right nipple line over the fifth rib and emerged in the midscapular line posteriorly between the ninth and tenth ribs. The wounds were of a sucking type and were treated by packing. One week later the dressings were bile soaked, and there was necrotic hepatic tissue in the drainage. Bile was expectorated in the sputum. Thirty-four days after wounding the chest was opened by resection of the fifth and sixth ribs in the axillary line. A finger-sized strand of tissue containing the fistula caused adhesion of the diaphragm to the lung. This was freed, and a large wedge-shaped cavity with thick connective tissue walls was found in the region of the fistula. Drainage of the chest was instituted. The patient improved, and the wound was closed twenty-two days later.

Elliott and Henry [10] in 1916 reported a case of a soldier in whom an infected hemothorax developed after a shrapnel wound of the left side of the chest. Some days later the sputum became bile streaked, and on the twenty-sixth day after the patient was wounded an empyema

9. Tyrman, J.: Ein Beitrag zur Kenntnis der Gallengang-Bronchusfistel, Arch. f. klin. Chir. **89**:434-450, 1909.

10. Elliott, T. R., and Henry, H. G. M.: A Case of Cholo Haemothorax, Brit. M. J. **1**:9 (Jan. 1) 1916.

cavity on the left side of the chest was drained surgically. The expectoration of bile continued for ten weeks, and during this period the patient coughed up one or two fleshy masses of necrotic liver tissue. The empyema closed in fourteen weeks, after which the patient made a rapid recovery. No mention is made of hemoptysis or of roentgen findings.

Loe and Loe [11] in 1930 reported the case of a 12 year old boy who fell into a well and suffered a penetrating wound of the right posterior wall of the chest with fracture of the right eighth rib. During the next four days the clinical course and physical findings suggested the diagnosis of a septic hemothorax on the right side. The child coughed considerably, with bloody expectoration. Thirteen days after the injury the sputum appeared yellow, and the patient complained of its bitter taste. Four days later aspiration yielded thick pus and a small amount of blood from the right side of the chest. Under local anesthesia a portion of the right ninth rib was resected, and old clotted blood and pus were evacuated from the pleural cavity. A thumb-sized adhesion extended upward from the dome of the right leaf of the diaphragm to the collapsed lung. When this connection was severed a profuse flow of bile was noted. Rubber tube drainage of this biliary fistula and of the chest was instituted. Coughing decreased after operation, and the expectoration of bile stopped immediately. Drainage of bile from the wound ceased in five days. The patient made a satisfactory recovery and a roentgenogram of the chest showed that it was normal five months later.

In 1913 Stumpff [12] recorded a case of long-standing biliary tract disease in which diaphragmatic pleurisy developed. This was aggravated when the patient was knocked down by a bicycle. Three days later expectoration of bile occurred. Death resulted ten weeks later, and autopsy showed obliteration of the common bile duct with a biliary-bronchial fistula involving it and the duodenum. It is doubtful if the fistula in this case can be attributed to trauma.

In view of the frequency in wartime of combined thoracoabdominal wounds involving both liver and lung, it is perhaps surprising that so few cases of traumatic biliary-bronchial fistulas have been reported. That this is not due to an excessive and early mortality rate is borne out by G. Gordon Taylor's [13] statistics that 70 per cent of patients with abdominothoracic wounds on the right side survive, and 50 per cent of those with similar wounds on the left side. Wounds of the liver are usually either rapidly fatal from hemorrhage, or else heal surprisingly

11. Loe, A. O. and Loe, R. H.: Bronchobiliary Fistula, S. Clin. North America **10**:1109-1117 (Oct.) 1930.

12. Stumpff, J. E.: Een geval van bilio-pulmonaal fistel, Nederl. tijdschr. v. geneesk. **1**:232-236, 1913.

13. Maingot, R.; Slesinger, E. S., and Fletcher, E.: Abdominal Injuries of Total Warfare, in War Wounds and Injuries, London, Edward Arnold & Co., 1937.

well. It is well known that portal blood and liver tissue harbor bacteria which may be pathogenic, but there is no evidence that wounds of the liver per se show any particular tendency to become infected. Elliott and Henry [10] report that in a study of approximately 500 wounds of the chest, many with associated hepatic damage, there were only two external biliary fistulas, both of which closed spontaneously within thirty days. It would seem, therefore, that when wounds of the liver become septic they are apt to do so as a result of retained foreign material or from sizable fragments of liver tissue which become necrotic as a result of loss of blood supply. One of us (C. C. G.) has, on numerous occasions, observed bullet paths through the liver at autopsy. If death has occurred several days after the wound is incurred the tract of the missile through the liver is lined by a yellow or yellow-brown zone representing bile-stained necrotic liver cells often surrounding a central small zone of hemorrhage. These necrotic cells are readily absorbed or walled off by granulation tissue, the recuperative power of the liver being remarkable. These granulations are replaced by scar tissue which readily blocks off the thin-walled compressible bile capillaries. If bile is to continue to escape from opened ducts or radicals, certain other pathologic features must exist. The intraductal biliary pressure may be elevated, and this undoubtedly is one explanation for the cases [14] of biliary-bronchial fistula which have followed surgical operations on the extrahepatic bile passages. If necrotic liver tisue exists, an abscess cavity may result with widespread opening of numerous bile ducts. In such cases the expectoration or drainage of the necrotic tissue is not surprising. With this type of pathologic process it would seem that the opening of numerous blood vessels should also occur if the bile channels are opened, and hemoptysis would result. Yet only in our case 1 has hemorrhage been an outstanding feature. We may conclude that biliary-bronchial fistula will continue to be an infrequent sequence of injuries to the liver since the factors necessary for its development usually either do not exist, or if present lead to early death from hemorrhage or sepsis. This perhaps accounts for the fact that these fistulas are either not mentioned [15] or are but briefly discussed [16] in some of the recent textbooks on disease of the chest and thoracic surgery. In the latter references no mention is made of a traumatic causation.

The pathologic symptoms and findings in biliary-bronchial fistula were discussed by Morton and Phillips,[3a] who noted that the first

14. French.[8b] Matrosov.[8b]

15. Sauerbruch, F., and O'Shaughnessy, L.: Thoracic Surgery, London, Edward Arnold & Co., 1937.

16. Cooke, R.: Diseases of the Chest, Edinburgh, E. & S. Livingstone, 1944. Graham, E. A.; Singer, J. J., and Ballou, H. C.: Surgical Disease of the Chest, Philadelphia, Lea & Febiger, 1935.

recorded cases were described by Mandard in 1854. The pathologic process must include adhesions between the liver and the diaphragm as well as adhesions between the diaphragm and lung. A potential cavity must originally exist either in the liver as an abscess, or in a walled off subphrenic or intrathoracic space. Large or dilated bile ducts and bronchi must both communicate with this space to form a fistula. The fistulous tract must have walls firm enough to prevent their collapse and closure by debris. The commonest location of the fistula is over the dome of the right lobe of the liver,[9] connecting with the posterior or lateral portion of the right lower pulmonary lobe. Fistulas through the left side of the diaphragm and left lung have been reported. The lining and walls of the bronchial tree show a surprisingly slight reaction to the bile.

Symptoms and findings in cases following trauma are usually those of hemothorax or of empyema in the early stages. The nature of the injury is such that trauma to the liver may be presumed. With the appearance of bile in the sputum the patient complains of a persistent and irritating cough. The quantity of bile expectorated may vary from barely enough to tint the sputum to 1,200 cc. daily. With it may be found blood in liquid or clotted form, debris and necrotic bits of liver tissue. The bile should be identifiable by the usual laboratory tests, but in our case 1 no conclusive positive results could be obtained by Obermayer's reagent or the nitric acid test. The reaction of the sputum is alkaline, which distinguishes it from that due to vomitus.

In these 6 cases 4 were clearly due to a combined thoracoabdominal bullet or shrapnel wound. In the case due to a kick by a horse we surmise that there were both pulmonary and hepatic injuries. The symptoms and findings in the traumatic cases should include evidences of injury both above and below the diaphragm. An apparent enlargement of the liver may be due to downward displacement of this organ from pressure by a subphrenic abscess, but this may be compensated by paralysis and elevation of the diaphragm. If the fistulous tract through the lung is small, there need be but little if any evidence of a pulmonary pathologic process on physical examination. Roentgen examination may reveal the pathologic area partially or completely, as it did in the early stage of our case 1 and in the later stage of case 2. Evidence of consolidation at the base of the lung or immobile diaphragm and some defect in the contour of the dome of the liver are to be sought. If the hepatic or subphrenic abscess is partly evacuated, a fluid level may be seen in it.

The diagnosis is obvious with the appearance of bile in the sputum, although if the patient is jaundiced the expectorated secretions may be yellow in the absence of a true fistula. In our case 1 as much as 250 cc.

of clear bile was expectorated daily and a great deal more was mixed with blood. The patient volunteered that the expectoration had a bitter taste "like bile."

Laird and Wilkerson [17] and Razemon [18] have described how the diagnosis can be made by bronchoscopic injection of iodized oil. This procedure should also be of value in determining the extent of the pathologic process even if it were not necessary for diagnostic purposes.

TREATMENT OF BILIARY-BRONCHIAL FISTULA

The treatment of biliary-bronchial fistula must be based on considerations of causation, duration and progress of the clinical findings and extent of the associated pathologic process. The prophylactic treatment is almost entirely a matter of the proper early treatment of thoracoabdominal wounds. This has now been fairly well established as a result of the accumulated war experiences of many surgeons and is adequately described in a recent article by Snyder.[19] He discusses the value of a transthoracic approach and advocates the subdiaphragmatic drainage of wounds of the liver when necessary through a separate subcostal or loin incision after tight closure of the diaphragm. He recognizes that fatal hemorrhage may occur from wounds of the liver that have not been packed or sutured, but believes that drains should never be brought out through the pleural cavity. This is unquestionably the choice of procedures in fresh wounds, but it is not applicable to late cases, as illustrated by case 1. When a biliary-bronchial fistula makes its appearance, regardless of the type of original wound or of the early surgical procedures, it becomes obvious that the essential pathologic condition contributing to this fistula is in the liver. Three courses of treatment then suggest themselves. The first is to do little or nothing in the hope that nature will effect a cure. Spontaneous recovery can be expected in about 50 per cent of cases,[3a] but may result only after a prolonged and debilitating illness, during which time other serious complications are to be feared. A conservative program was followed in case 1 until the severe and repeated hemorrhages made it apparent that the patient would die of exsanguination without radical surgical aid. In less severe cases, crushing of the phrenic nerve and pneumothorax therapy might be of some help, but they were of no value to this patient, and it is difficult to believe that much could be expected of such measures when the essential pathologic process is in the liver.

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17. Laird, W. R., and Wilkerson, W. V.: Biliary-Bronchial Fistula: First Recorded Case Demonstrated by Lipiodol, Am. J. Surg. **15**:317-320 (Feb.) 1932.

18. Razemon, P.; Bizard, G., and Lambret, M.: Biliary-Bronchial Fistula, Following Lithiasis with Report of a Case, Rev. de chir., Paris **52**:485-505 (July) 1933.

19. Snyder, H. E.: The Management of Intra-Thoracic and Thoraco-Abdominal Wounds in the Combat Zone, Ann. Surg. **122**:333-357 (Sept.) 1945.

The second method of treatment is to establish drainage of the subphrenic space and liver abscess without disturbing the lung. Morton and Phillips [3a] recommended this method of treatment, using local anesthesia and entering the subphrenic space through the diaphragm below the pleural reflection. They argued that this approach avoids the danger of pneumothorax and infection of the pleural cavity and that adhesions in the subphrenic space prevented peritoneal contamination. The subdiaphragmatic approach was employed in case 2 but repeated operations were necessary to establish adequate drainage. Entrance into a liver abscess through the subphrenic space is not easy if that space is obliterated by dense adhesions, as it may be if the disease is of considerable duration. This approach does not facilitate closure of the opening through the diaphragm.

The third method of attack is through the pleural cavity and it would appear to be the one of choice in the majority of such cases. This permits the lung to be freed from the fistulous opening in the diaphragm, after which the bronchial fistula may be closed. It allows exploration of the lower pleural cavity and drainage of any pockets of pus, blood or bile. Through this approach it is possible to enlarge the fistulous opening in the diaphragm and to explore the subphrenic space and underlying hepatic lobe. It permits the evacuation and packing of a cavity in the liver and, as illustrated by case 1, such a cavity may be repacked at frequent intervals if necessary. The objections to this approach are that it may open up uninfected areas of the pleura, and that it produces an open pneumothorax with consequent pulmonary collapse of some degree. These objections in our opinion are not of sufficient importance to outweigh the obvious advantages.

SUMMARY AND CONCLUSIONS

Four cases of biliary-bronchial fistula due to external violence have previously been described. We add two more, making a total of only 6 reported so far. These apparently have all resulted from combined thoracoabdominal injuries, 4 of them being due to bullet or shrapnel wounds. An explanation is suggested for their rarity in view of the large number of wartime injuries of this nature. The essential pathologic process is in the liver, and effective surgical therapy must be primarily directed to this organ. A transthoracic approach is recommended for closure of the bronchial fistula and for adequate exploration of the pulmonary, pleural, diaphragmatic and hepatic lesions. Drainage through this approach and repeated packing, if necessary, of a bleeding hepatic abscess cavity is readily accomplished.

CONGENITAL ATRESIA AND TRACHEOESOPHAGEAL FISTULA

Four Consecutive Cases of Successful Primary Esophageal Anastomosis

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THE CASES discussed in this paper are presented with two purposes in mind: (1) to direct attention again to a congenital anomaly which if untreated is incompatible with life, but which now can frequently be satisfactorily corrected by surgical procedures, and (2) to discuss certain steps in the care of these patients which have not been emphasized in previous reports by others.

The most common congenital anomaly of the esophagus is complete atresia; the upper segment ends in a blind pouch and the lower segment communicates with the trachea near the bifurcation. It is now generally agreed that in these cases the esophagus should be explored, the fistula ligated and if possible an end-to-end anastomosis of the esophagus, as recommended by Haight,[1] performed. If the anomaly is such that an anastomosis is not feasible, the oral segment is exteriorized, the fistula ligated at the trachea and a gastrostomy performed. The two external fistulas are later joined by some type of antethoracic channel (Ladd,[2] Longmire and Ravitch [3]).

From March 1945 to November 1946, 5 infants with congenital atresia of the esophagus and tracheoesophageal fistula were operated on. In all instances the fistula was ligated and an end to end anastomosis of the esophagus performed. The first patient died immediately after operation. In the last four consecutive cases the operations have been successful. These children are taking all feedings by mouth and are gaining weight satisfactorily. One infant in whom a successful repair was performed was born prematurely at seven months' gestation, and weighed only 1,400 Gm. (3.1 pounds) at the time of operation. In general, our treatment in these cases has followed that recommended by Haight.[1]

From the Department of Surgery of the Johns Hopkins University School of Medicine and Johns Hopkins Hospital.

1. Haight, C., and Towsley, H. A.: Surg., Gynec. & Obst. **76**:672, 1943. Haight, C.: Ann. Surg. **120**:623, 1944.

2. Ladd, W. E.: New England J. Med. **230**:625, 1944.

3. Longmire, W. P., and Ravitch, M. M.: Ann. Surg. **123**:819, 1946.

DIAGNOSIS AND PREOPERATIVE TREATMENT

Diagnosis and preoperative treatment have been amply discussed by Haight,[1] Humphreys,[4] Daniel,[5] Ladd,[2] Lam[6] and others. There are a few pertinent points, however, which should be emphasized.

Passing a small catheter down the esophagus as a diagnostic measure may give misleading information unless the procedure is carried out under a fluoroscope, as the catheter may double back in the dilated upper esophageal pouch so readily as to give the impression that it is

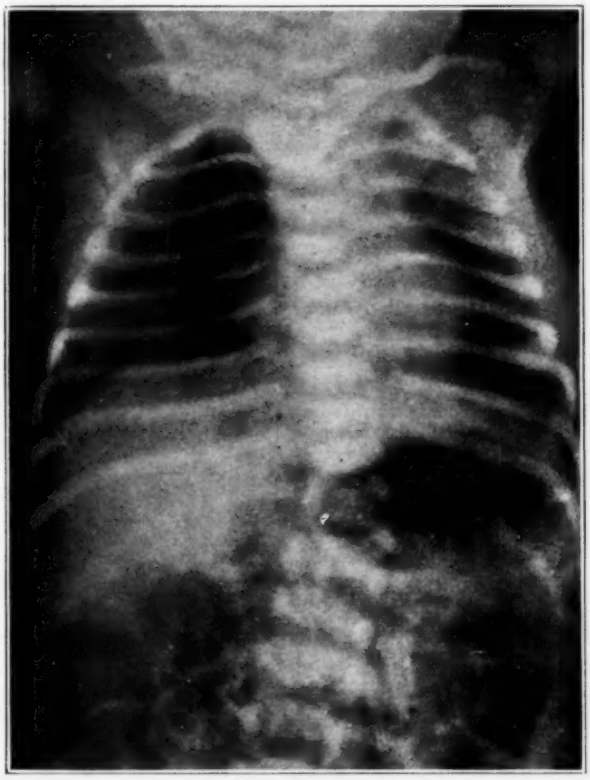

Fig. 1.—Roentgenogram of chest and abdomen of J. B. The oral segment of the esophagus filled with iodized poppyseed oil ends at the level of the second dorsal vertebra. Fluoroscopy demonstrated that segment descends to the level of the fourth dorsal vertebra. Air in the stomach and intestine indicates communication between the distal esophageal segment and trachea.

passing through the esophagus into the stomach. This mishap occurred in 1 case and delayed the proper diagnosis for several hours.

4. Humphreys, G. H.: Surgery **15**:801, 1944.
5. Daniel, R. A.: Ann. Surg. **120**:764, 1944.
6. Lam, C. R.: Surgery **20**:174, 1946.

Before operation the length of the upper esophageal pouch can best be determined by observing the segment filled with iodized poppyseed oil 40 per cent or diodrast under the fluoroscope. The segment undergoes frequent contractions as the infant cries or swallows, and if only a single roentgenogram is taken it may happen to be made during a period of contraction. Thus the picture will show such a short oral segment that the advisability of attempting a primary esophageal anastomosis might be questioned, whereas a much greater length would be demonstrated by fluoroscopy (fig. 1). Immediately after the roentgen examination the opaque material is removed from the upper esophageal segment to prevent its aspiration. If too great a quantity of opaque solution is placed in the oral segment it may be aspirated into the lower

TABLE 1.—*Condition of Patients Before Operation*

Case	Age	Term or Premature	Weight, Gm.	Level Upper Segment	Air in Stomach	Pneumonia	State of Hydration	Type Anomaly (Vogt)	Other Anomalies
C. M.	6 days	Premature 7 months	1,600	4th dorsal vertebra	Yes	No	Good	III B	Cleft palate, atresia external auditory canal, left
T. P.	6 days	Term	2,420	5th dorsal vertebra	Yes	No	Good	III B	None
M. A.	6 days	Term	2,510	4th dorsal vertebra	Yes	No	Fair	III B	Meningocele
J. B.	3 days	Term	2,400	4th dorsal vertebra	Yes	Rales at both lung bases	Good	III B	None
P. W.	3 days	Premature	1,400	3rd dorsal vertebra	Yes	No	Good	III B	Atresia of anus; rectovaginal fistula

portion of the trachea. A subsequent roentgenogram of the chest may show the material below the level of the blind pouch, thus suggesting that the patient has a stricture of the esophagus rather than a true atresia.

All of the infants in the series discussed in this paper were in relatively good general condition when first seen, and after a brief interval to allow adequate hydration and blood transfusion, operation was performed. Constant suction was maintained by means of a catheter in the nasopharynx, and penicillin was given until the time of operation. The condition of these patients before operation is summarized in table 1.

OPERATIVE TECHNIC

In all cases ether-cyclopropane anesthesia was used, and no ill effects from the anesthesia have occurred. Quiet respirations were considered essential for the

delicate anastomosis. It is very important that a small catheter be placed through the nose or mouth into the upper segment and constant suction maintained throughout the operation. In 2 cases this was not done, and the omission probably caused the death of the first infant and almost caused the death of the second. In both instances the operation progressed satisfactorily until the mediastinum was opened and mobilization of the upper esophageal segment begun. At this point evidence of severe respiratory obstruction developed. In the first patient this was considered a result of a small opening which had been made in the pleura although there had been no change in the respirations for several minutes after this opening was noted. The operation was continued under positive pressure anesthesia. The anesthetist reported that an unusually high pressure was required to obtain adequate respiratory exchange. At the end of the operation an unsuccessful attempt was made to aspirate the trachea, and the child died a short time later with signs of respiratory obstruction. In the next case similar signs appeared at the same stage in the operative procedure, and as the pleura was intact it was felt certain that the respiratory embarrassment was due to an obstruction in the trachea. Rapid intratracheal aspiration of a small plug of mucus by the anesthetist, Dr. Merel Harmel, completely relieved the obstructive sign. Undoubtedly manipulation caused contraction of the upper esophageal segment and emptying of accumulated mucus, which was then drawn into the trachea. Since that time a suction catheter has always been left in the upper segment throughout the operation, and there has been no further interference with pulmonary ventilation durng the procedure. It is possible that some of the respiratory difficulties which have been attributed to the presence of an accidental pneumothorax during this operation may best be explained on this basis.

A right posterior extrapleural approach was used. Segments of the third, fourth and fifth ribs were resected and the pleura was reflected. In the smaller infants it was easy to pass posterior to the mediastinum into the opposite side of the thorax if the vertebral column was not carefully watched for. The upper esophageal segment was localized by palpating the catheter, and the prevertebral fascia was opened in this region. The lower segment was usually found distal to the end of the upper blind pouch by identifying the trachea and following it caudally. In the last 2 cases it has not been necessary to divide the azygos vein; and as division of the vein entails considerable risk of perforating the pleura and is about the only step from which serious hemorrhage may arise in the right-sided approach, it is felt that the omission of this step is desirable if possible. Unless the lower segment enters a bronchus or ends in the lower part of the mediastinum, division of the azygos vein probably is unnecessary. The esophagus is freed sufficiently to allow the ends to be rotated during the anastomosis, but extensive mobilization of either end has been avoided whenever possible as this tends to interfere with the circulation and creates a larger dead space in the mediastinum for possible infection; and as the esophagus tends to contract longitudinally when freed from its bed, tension on the suture line may actually be increased by wide mobilization. In attempting to make the opening at the most dependent point of the upper blind pouch the suction catheter is advanced until the pouch is elongated, and the opening is made where the tip of the catheter can be palpated through its wall.

The "telescopic" anastomosis described by Haight has been performed in each instance. Two rows of interrupted 5-0 "deknatal" silk sutures have been used. The anastomosis has not been performed over a catheter, as it has been found easier to identify the various layers of the esophageal segments if the lumen is visible. A catheter is passed through the completed anastomosis to test its patency but is immediately removed. In 1 case a catheter was passed through the anastomosis into

the stomach and left in place for ten days. This completely obstructed the passage of saliva through the esophagus, and a second catheter placed in the nasopharynx was necessary to prevent the aspiration of mucus. Such postoperative obstruction of the esophagus undoubtedly increases the risk of aspiration pneumonia. Haight has pointed out that the distention of the small lower segment by such a catheter might well interfere with the blood supply and the healing at the anastomotic area.

A small rubber tissue drain has routinely been placed in the retropleural space. The advantage of maintaining a higher local concentration of penicillin by closing the incision without drainage has recently been discussed by White and Birdsong.[7]

POSTOPERATIVE CARE

The infants are maintained on fluids parenterally administered for forty-eight hours after operation. At this time a Stamm type gastrostomy is routinely performed through a small upper midline incision. At this stage in the postoperative course such a procedure on a well hydrated infant offers little risk. On the other hand, if the operation is delayed until it is made necessary several days later by the development of a stricture or a leak in the anastomosis, the general condition of the infant may be less satisfactory, intravenous therapy quite difficult because of repeated use of all external veins, and the hazards of the procedure greatly increased. Early retrograde dilation through the gastrostomy opening is easily performed if signs of stenosis of the anastomosis appear.

Twelve hours after the gastrostomy has been established small frequent feedings are given through the tube. If the esophageal anastomosis heals satisfactorily a small portion of the gastrostomy feeding is given by mouth on the seventh day after the first operation, and the quantity of the oral feedings is steadily increased until gastrostomy feedings are eliminated. My colleagues and I have maintained the gastrostomy opening for a period of three months to permit retrograde dilations of the esophagus if necessary. Although there is a certain esthetic satisfaction in having such a patient recover without the performance of gastrostomy, there seems little else to recommend the omission of this procedure.

COMPLICATIONS

In 2 of the patients an external fistula developed from the site of the anastomosis after operation. In 1 case the fistula appeared on the tenth day after operation[8] and in the other patient on the fifth post-

7. White, M. L., Jr., and Birdsong, M.: Surgery **20**:548, 1946.

8. A catheter had been left in place through the anastomosis after operation, and we feel that it was at least in part responsible for the development of the fistula. The fistula drained much more in this patient than in the other and it healed more slowly, and the stricture which subsequently formed has responded rather slowly to dilations.

operative day. Of the sixteen successful direct anastomoses which have been reported to date, a temporary external fistula has developed in four. Two other patients reported by Haight were known to have a localized leak from the anastomosis which did not drain externally. In both of our cases external drainage ceased spontaneously within eleven days. During the presence of the fistulas continuous suction was maintained in the upper esophageal segment by means of a catheter, and small frequent feedings were given through the gastrostomy.

Fig. 2.—M. A., three and one-half months after operation. Gastrostomy opening is closed. The general condition is excellent.

Every effort was made to prevent the gastric juice or gastric contents from entering the sinus tract. As we feared that the presence of a radiopaque substance in the tract might tend to retard spontaneous healing, no attempt was made to demonstrate the fistula by roentgen examination. The prompt spontaneous closure of the defect suggests that these measures are sound.

In 2 patients a stricture developed at the anastomosis. One of these became evident three weeks after the closure of an external fistula,[8]

Fig. 3.—J. B. one month after operation. Incision is well healed. Gastrostomy tube is in place, but the child takes all feedings by mouth.

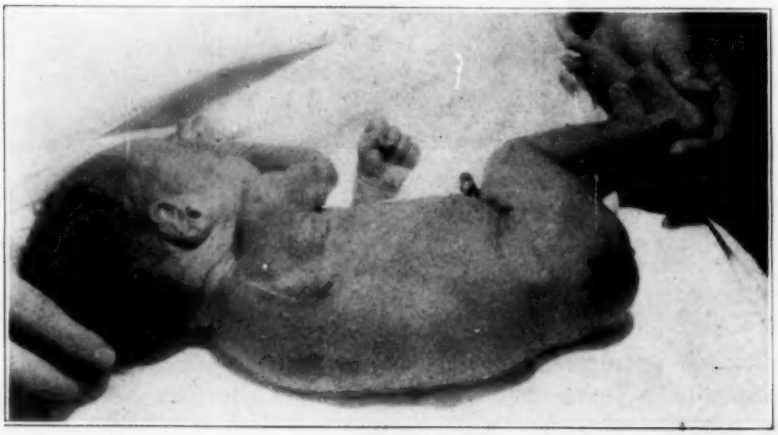

Fig. 4.—P. W., incision is well healed, the patient taking all feedings by mouth two weeks after operation. The child weighed 3 pounds (1,306.7 Gm.) at the time of operation.

the other developed in a patient in whom the anastomosis had healed primarily. At the first sign of stenosis the esophagoscope was used, the nature of the stenosis was determined,[9] and a string was passed through the esophagus for biweekly retrograde dilations through the gastrostomy. Dilations were continued until a no. 20 French dilator could be passed with ease. The children took all feedings by mouth regularly. The experience of others thus far seems to indicate a better prognosis as regards such strictures than in the case of the usual caustic or traumatic stricture. Several cases have been reported in which an early stricture at the anastomosis has disappeared as the child grew

TABLE 2.—*Postoperative Course and Results in Infants in Present Series*

Case	Date of Operation	Operation	Gastrostomy	External Fistula	Stricture	Interval Since Operation	Condition
C. M.	3/ 1/45	Right extrapleural mediastinal exploration, ligation tracheoesophageal fistula, end to end anastomosis esophagus	.....	.....	.....	.....	Died fifteen minutes after completion of operation
T. P.	7/27/46	Right extrapleural mediastinal exploration, ligation tracheoesophageal fistula, end to end anastomosis esophagus	Yes 8/12/46	Yes; appeared 8/6/46; closed 8/17/46	Yes; appeared 9/6/46	6 mos.	Retrograde dilations by L. M. D. French no. 22 dilator passed easily once a week; taking all feedings by mouth; gaining weight satisfactorily
M. A.	8/17/46	Right extrapleural mediastinal exploration, ligation tracheoesophageal fistula, end to end anastomosis esophagus	Yes 8/19/46	Yes; appeared 8/22/46; closed 8/26/46	No	5 mos.	Taking all feedings by mouth; gastrostomy opening closed; esophagus narrowed at site of anastomosis but barium passes readily; meningocele repaired 12/21/46
J. B.	11/ 1/46	Right extrapleural mediastinal exploration, ligation tracheoesophageal fistula, end to end anastomosis esophagus	Yes 11/4/46	No	Yes; appeared 11/15/46	2½ mos.	Retrograde dilations weekly by L. M. D. with French no. 20 dilator; takes all feedings by mouth; gaining weight satisfactorily
P. W.	11/22/46	Right extrapleural mediastinal exploration, ligation tracheoesophageal fistula, end to end anastomosis esophagus	Yes 11/24/46	No	No	2 mos.	Excellent; takes all feedings by mouth; retrovaginal fistula closed and rectum brought to outside through rectal sphincter

older. Certainly a localized stricture of this type should respond better to dilations than the broad extensive scarring encountered in the severe caustic stricture. The great increase in the size of the entire esophagus as the child grows should also help to increase the lumen of the stenotic area.

COMMENT

The most important step in the management of these cases is the early recognition of the anomaly by the attending physician before the

9. Esophagoscopy demonstrated the anastomosis to be well healed but narrowed in one patient. In the other patient the lumen at the anastomosis was narrowed and partially obstructed by granulation tissue. This patient has responded more slowly to dilations.

infant's life is seriously threatened by aspiration pneumonia or dehydration and starvation. The success or failure of the operative procedure depends in large part on the general condition of the patient at the time of operation. Prior to Haight's report of the first successful case in 1943 these anomalies were generally considered incurable and their recognition of relatively little importance. The 4 consecutive successful cases in the present series, it is hoped, will emphasize the belief that this view is no longer tenable.

It has previously been suggested that infants having this anomaly and weighing less than 4 pounds (1.8 Kg.) at birth probably should not be operated on. Two of the patients in this series were under this minimal birth weight, and in both it was technically possible to perform a satisfactory anastomosis. The first child died immediately after operation from a condition which I now believe can be prevented. In the second child the anastomosis healed by first intention and the repair has been one of the most satisfactory in this series. Operation should not be deferred solely because of the infant's weight.

SUMMARY

Four consecutive patients with tracheoesophageal fistula and esophageal atresia have survived ligation of the fistula and primary anastomosis of the esophagus. They are now taking all feedings by mouth and are gaining weight satisfactorily. One of these patients weighed only 3.1 pounds at the time of operation. Certain features of the diagnosis, the operative technic and the postoperative care are discussed. The importance of the early recognition of the condition by the attending physician is emphasized.

The anomaly was originally recognized in patient T. P. by Dr. R. W. Frankmann of Massillon, Ohio, and in patient J. B. by Captain Robert T. Parker of Fort Eustis, Va.

Since the completion of this paper an excellent report by Ladd and Swenson of the cases of atresia of the esophagus and tracheoesophageal fistula at The Children's Hospital, Boston, has appeared. Among the last 14 patients treated by primary anastomosis there has been only one death.[10]

10. Ladd, W. E., and Swenson, O.: Ann. Surg. **125**:23, 1947.

OPEN REDUCTION FOR FRACTURES OF THE PELVIC GIRDLE

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OPEN reduction for derangement of the pelvic girdle is rarely mentioned in the literature. Noland and Conwell [1] resorted to two open reductions in a series of 185 cases of fracture of the pelvis. They stated that the only reason for surgical intervention is pressure of the fragments on the bladder or the rectum. Their procedure is not described. Leadbetter [2] found it necessary to operate in 2 cases out of a total of 78 reported. His indication for operation was overriding, irreducible fragments. In regard to operative technic, he simply stated that an incision is made over the superior ramus which is reduced and fixed. The inferior ramus is disregarded. Wilson [3] advocated bringing the fractured rami together and fixing them with silver wire. Kreucher [4] concurred with Noland and Conwell's criteria for operation, but reported no operative case. Steele [5] has done two open reductions for Malgaigne fracture. He placed a dowel type of bone graft across the symphysis pubis and two weeks later performed arthrodesis of the sacroiliac joint. Tierny [6] expressed the belief that double vertical fractures of the pelvis require open reduction. He advocated making an incision in the anterior part of the perineum in the genitocrural groove, securing the pubic arch with a piece of Parham band and then fixing the wing of the ilium to the sacrum with a 5 cm. wood screw. He added that his patients walk in one month, but he did not report any cases.

From the Department of Surgery, Baylor University College of Medicine, and Hermann Hospital.

1. Noland, L., and Conwell, H. E.: Acute Fractures of the Pelvis, J. A. M. A. **94**:174 (Jan. 18) 1930; Fractures of the Pelvis, Surg., Gynec. & Obst. **56**:522 (Feb.) 1933.

2. Leadbetter, G. W.: Fractures of the Pelvis, South. M. J. **25**:742 (July) 1932.

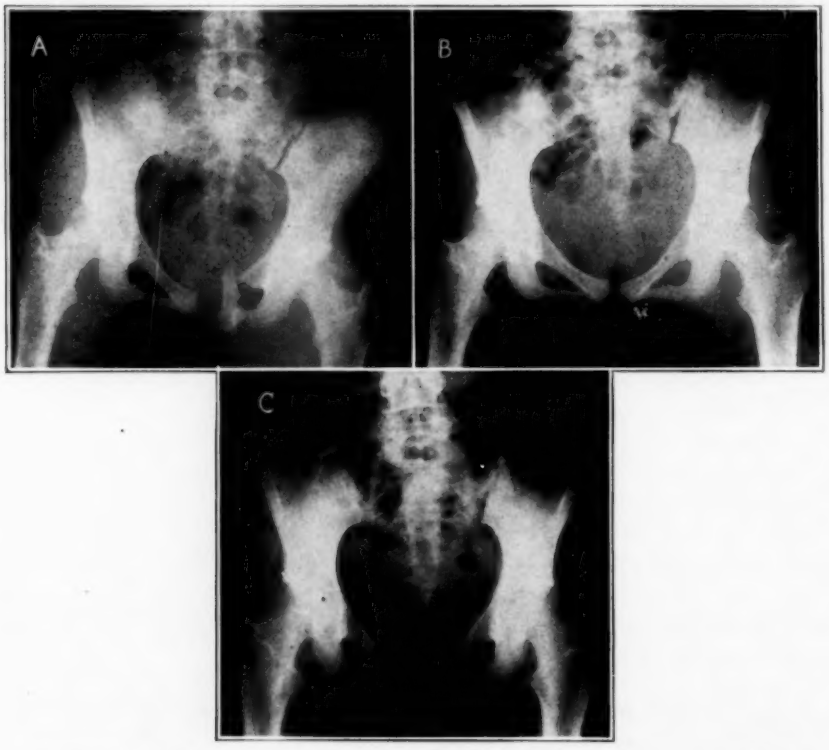
3. Wilson, G. E.: Fractures of the Pelvis, St. Michael's Hosp. M. Bull. **3**:56 (Dec.) 1927.

4. Kreucher, P. H.: Fractures of the Pelvis, Indust. Med. **5**:185 (April) 1936.

5. Steele, P. B., in Bancroft, F. W., and Murray, C. R.: Surgical Treatment of the Motor Skeletal System, Philadelphia, J. B. Lippincott Company, 1945, p. 805.

6. Tierney, A.: Osteosynthesis of Double Cervical Fracture of the Pelvis, Mém. d. Acad. de chir. **65**:831 (June) 1939.

The amount of displacement of fractures of the pelvic girdle is of clinical importance only when it involves wide spreading of the symphysis pubis, marked elevation of one side of the pelvis or impending damage to a viscus or major blood vessels. In such cases, when accurate anatomic reduction is imperative and manipulation is dangerous or impossible, open reduction offers the only solution to the problem. Therefore we wish to present this illustrative case with a technic for open reduction that we have not found previously described in the literature.



A, anteroposterior view of the pelvis taken at the time of the patient's admission to the hospital. The medial fragment is rotated almost 90 degrees on its axis. Note the separation of the sacroiliac joint. *B*, the postoperative roentgenogram, showing excellent alinement of the pubic fractures. There is little or no change in the sacroiliac joint. *C*, this view, taken seven weeks after open reduction, reveals bony union of the pubic fracture but still little change in the sacroiliac joint. There were no symptoms referable to the sacroiliac region or symphysis pubis at this time.

REPORT OF A CASE

D. P., a white girl aged 16, was admitted to Hermann Hospital on May 29, 1946 after an automobile accident. She complained of severe pain in the pelvis with radiation of the pain to both legs. There was moderate swelling of the right leg and tenderness over the right pubis. The right femoral pulse could be palpated

but was weaker than that on the left. The blood pressure was 130 systolic and 80 diastolic, the temperature was 99.6 F. and the respiration rate was 18.

Urinalysis showed 5 to 10 red blood cells per low power field. Other laboratory data and physical observations did not show any abnormality.

A cystogram was done shortly after admission and no trauma to the wall of the bladder could be demonstrated, nor was any extravasation of the opaque mediums noted.

Roentgenograms of the right femur revealed no fracture; those of the pelvis revealed a Malgaigne type of fracture on the right side (fig. 1).

In view of the swelling of the right leg and diminution of the femoral pulse, open reduction was decided on and performed June 4.

A satisfactory reduction of the pubis was obtained, but there was little change in the sacroiliac separation (fig. 2).

Postoperatively a Roger Anderson well leg traction apparatus was applied with the hope of improving the position of the sacroiliac relationship. This was worn for six weeks. The pelvis was left unsupported throughout the postoperative convalescence. Eight weeks after operation the patient was walking without assistance. On July 26 the roentgenologist reported firm bony union of the pubic fractures (fig. 3). The patient was last seen on September 15, at which time she was carrying out her normal activities without any complaints.

DESCRIPTION OF OPERATION

The operation was performed as follows: A Pfannenstiel type of incision was made through the skin and subcutaneous fascia. The anterior aponeurosis of the rectus muscles was incised transversely and the interval between the rectus muscles freed by blunt and sharp dissection, thus mobilizing the rectus muscles. The sheath of the rectus was then incised transversely after retracting the rectus muscles laterally. The peritoneum was avoided by inflating the bladder and later collapsing it. The fascia and periosteum over the superior ramus were incised transversely and the site of the fracture exposed by subperiosteal dissection. Since the fracture was now fully mobilized it could easily be reduced, and if it was not comminuted no internal fixation was required. The wound was closed in layers, and the fracture could then be treated as a nondisplaced pelvic fracture.

CONCLUSIONS

We believe that this approach has the following advantages: The wound is less liable to infection in that it is more removed from the perineal region than other incisions. By section of the rectus and its sheath the medial fragment is mobilized and reduction is thus greatly facilitated. The pelvic viscera and vessels may be observed and the danger of damaging these structures during manipulation of the fragments is eliminated. Large hematomas, which are frequently present, may be evacuated.

It is also felt that if the surfaces of the sacroiliac joint are brought into reasonably close approximation arthrodesis or other fixation is not necessary. This is also true of the symphysis pubis.

SUMMARY

The literature bearing on open reduction for fracture of the pelvic girdle has been briefly reviewed. The indications for open reduction are cited. An illustrative case is presented. A surgical approach for reduction of the fractures, which we have not found previously suggested, has been described.

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EFFECTS OF SUPRADIAPHRAGMATIC SECTION OF THE VAGUS NERVES IN MAN

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VARIOUS studies have been performed on a group of patients undergoing section of the vagus nerves for peptic ulceration [1] on the Third (New York University) Surgical Division, Bellevue Hospital. Moreover, Dr. Frank B. Berry, Director of the First (College of Physicians and Surgeons) Surgical Division, has permitted us to make observations on a small group of patients undergoing similar procedures on that service.

We have outlined a plan of investigation devoting attention not only to alterations in gastric physiology but to other visceral functions proved or suggested by animal experimentation to be mediated through the vagus nerves. All of these studies require further pursuit and analysis. However, certain findings which seem to us to be of some significance are presented at this time. They are as follows: (1) the effect of alcohol intragastrically and intravenously on secretion of gastric acid, and its relation to the effect of histamine; (2) the result of nitrogen balance studies on patients subjected to section of the vagus nerves; (3) the results of electroencephalographic tracings before and after operation, and (4) that which appears to us to be the effect most unpleasant to the patient—namely, diminished gastric motility.

Read at the Clinical Congress of the American College of Surgeons, Cleveland, Dec. 19, 1946.

1. (*a*) Dragstedt, L. R., and Owens, F. M.: Supra-Diaphragmatic Section of the Vagus Nerve in Treatment of Duodenal Ulcer, Proc. Soc. Exper. Biol. & Med. **53**:152-154, 1943. (*b*) Dragstedt, L. R., and Schafer, P. W.: Removal of the Vagus Innervation of the Stomach in Gastroduodenal Ulcer, Surgery **17**: 742-749, 1945. (*c*) Dragstedt, L. R.: Vagotomy for Gastroduodenal Ulcer, Ann. Surg. **122**:973-989, 1945.

All patients on whom physiologic observations are herein reported underwent transthoracic supradiaphragmatic section of the vagus nerves for duodenal or gastrojejunal ulcer. Our technic is similar to that described by Grimson.[2] Lack of secretion of gastric acid in response to hypoglycemia induced by 15 units of insulin administered intravenously was the criterion used for evaluation of complete vagal section.[3] In the performance of the gastric tests, the fasting stomach was aspirated as thoroughly as possible by stomach tube. The secretion of gastric acid was determined in the usual way by Topfer's reagent and phenolphthalein on fractional specimens. The alcohol test meal consisted of

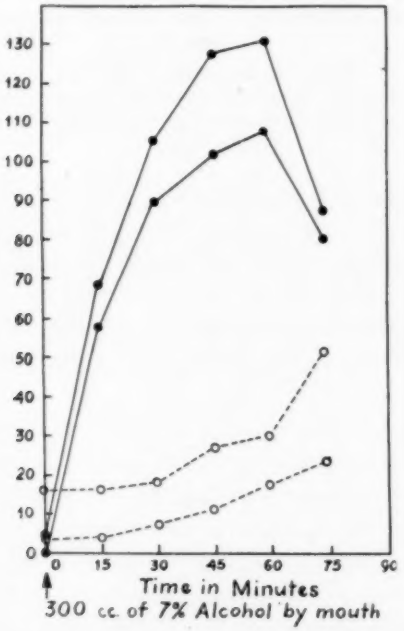

Chart 1.—Gastric acid values after alcohol test meal. The solid lines indicate values before operation and the dotted lines values after operation. The patient was T. H.

300 cc. of 7 per cent ethyl alcohol introduced into the stomach. For the intravenous method, 0.25 cc. of absolute ethyl alcohol per kilogram of body weight was made up into a 25 per cent solution by dilution with

2. Grimson, K. S.; Taylor, H. M.; Trent, J. C.; Wilson, D. A., and Hill, H. C.: The Effect of Transthoracic Vagotomy upon the Functions of the Stomach and upon the Early Clinical Course of Patients with Peptic Ulcer, South. M. J. **39**:460-472, 1946.

3. Jemerin, E. E.; Hollander, F., and Weinstein, V. A.: A Comparison of Insulin and Food as Stimuli for the Differentiation of Vagal and Non-Vagal Gastric Pouches, Gastroenterology **1**:500-512, 1943.

sterile distilled water and introduced into an antecubital vein.[4] Studies were performed before and after operation and a comparison of results was made.

In the 7 cases in which the alcohol gastric test meal was employed, all demonstrated a definite decrease in the amount of free and total acid secreted after supradiaphragmatic section of the vagus nerves (chart 1).

Observations were made on 2 patients to whom the alcohol was administered by the intravenous route. A similar definite decrease in the amount of free and total acid was found following section of the vagus nerves (chart 2).

To 1 patient the usual alcohol test meal was given, followed in two hours by the administration of 1 mg. of 1 to 1,000 histamine dihydro-

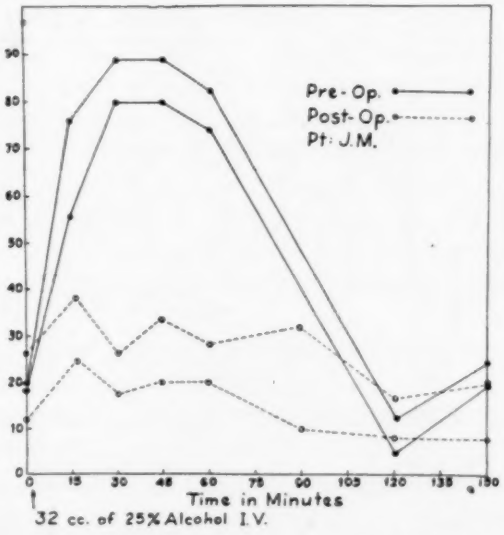

Chart 2.—Gastric acid values after intravenous administration of alcohol. The solid lines indicate values before operation and the dotted line values after operation. The patient was J. M.

chloride subcutaneously. After transthoracic section of the vagus nerves there was found to be a decrease in the amount of free and total acid in response to alcohol, but no change with histamine (chart 3). The response to histamine is in accord with the observations of Thornton, Storer and Dragstedt,[5] who have reported that in 19 patients in whom

4. Newman, H. W., and Mehrtens, H. G.: Effect of Intravenous Injection of Ethyl Alcohol on Gastric Secretion in Man, Proc. Soc. Exper. Biol. & Med. **30**: 145-148, 1932.

5. Thornton, T. F., Jr.; Storer, E. H., and Dragstedt, L. R.: Supradiaphragmatic Section of the Vagus Nerves: Effect on Gastric Secretion and Motility in Patients with Peptic Ulcer, J. A. M. A. **130**:764-771 (March 23) 1946.

histamine produced an abundant secretion of acid gastric juice before operation there was no diminution either in volume or in free acidity after section of the vagus nerves.

One theory that has been proposed as to the manner in which alcohol increases secretion of gastric acid is that it acts on the gastric glands by liberating histamine.[6] Since section of the vagus nerve appears to alter the gastric acid response to alcohol and does not alter the response to histamine, the evidence suggests a dissociation of the means by which these drugs effect secretion of gastric acid.

Nitrogen balance studies were done on 4 patients under the direction of Dr. Co Tui. The nitrogen balance was positive by the fourth or fifth day, which is the usual finding in patients undergoing operations of comparable type and magnitude. The figures for fecal nitrogen were

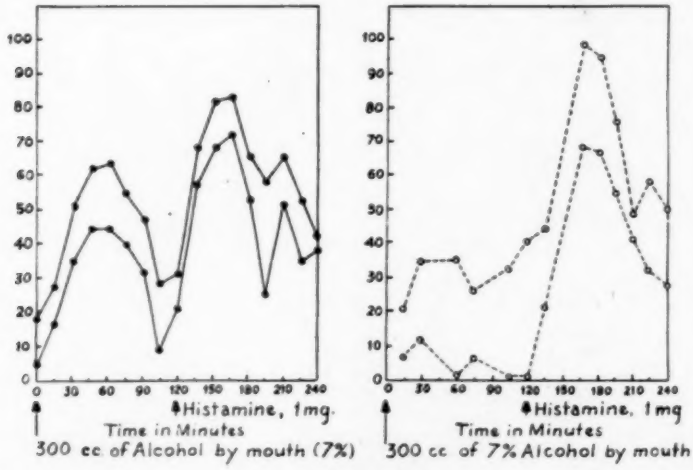

Chart 3.—Gastric acid values after alcohol test meal and injection of histamine. The chart at left indicates values before operation and the chart at right values after operation. The patient was I. G.

within or below normal limits. These facts suggest that there has been no impairment of utilization and absorption of protein.

Electroencephalograhic studies were done by Dr. Margaret Kennard. Six patients had electroencephalographic tracings before and at intervals varying from two days to two months after supradiaphragmatic section of the vagus nerves. All showed a pattern varying from the normal,

6. Dragstedt, C. A.; Gray, J. S.; Lawton, A. H., and Ramirez de Arellano, M.: Does Alcohol Stimulate Gastric Secretion by Liberating Histamine? Proc. Soc. Exper. Biol. & Med. **43**:26-28, 1940. Ivy, A. C.: The Mechanisms of Gastric Secretion (E. Starr Judd Lecture), Surgery **10**:861-878, 1941. Babkin, B. P.: Secretory Mechanism of the Digestive Glands, New York, Paul B. Hoeber, Inc., 1944.

demonstrating either a high percentage of alpha activity or a pattern in which low voltage fast activity was dominant. Neither group showed any significant change in electroencephalographic pattern following section of the vagus nerves. This would indicate that the abnormal electroencephalographic patterns found in a high percentage of patients with peptic ulcer [7] were not caused by afferent stimuli traversing the vagus nerves.

Of great concern to patients submitted to supradiaphragmatic section of the vagus nerves for duodenal ulcer has been the disturbance of gastric motility. Previous authors have described the occurrence of diminished gastric motility [8] and warned of the dangers of simple section of the vagus nerves in the presence of pyloric obstruction.[9] None of our patients on whom supradiaphragmatic section of the vagus nerves was performed had pyloric obstruction. None had gastric retention of a barium meal beyond three hours. However, all had histories of duodenal ulcer of at least eight years' duration. After operation, all have shown evidence of diminished gastric tone manifest by: (1) a dilated stomach demonstrated by roentgenographic examination; (2) retention of food in many instances for twenty-four to forty-eight hours as found by gastric aspiration (in some patients the dilation is extraordinary and unless treated by aspiration and suction is alarming), and (3) subjective symptoms of fulness, distention, gaseous eructations and an unpleasant taste in the mouth.

Most patients have been pleased with their improvement, relief of pain and increased appetite for the first two weeks after operation. They then become dissatisfied because of the symptoms which we believe arise from diminished gastric motility in the presence of duodenal scarring. All patients have gained weight, and most weigh more now than at any other time in their lives. Meanwhile, other patients with ulcer have been content with the clinical result brought about by subtotal gastric section or by infradiaphragmatic section of the vagus nerves with accompanying posterior gastroenterostomy. Strikingly encouraging results, immediately and on short term follow-up, have followed transthoracic supradiaphragmatic section of the vagus nerves in the presence of stomal gastrojejunal ulcer.

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7. Rubin, S., and Bowman, K. M.: Electroencephalographic and Personality Correlates in Peptic Ulcer, Psychosom. Med. **4**:309-318, 1942. Moses, L.: Psychodynamic and Electroencepalographic Factors in Duodenal Ulcer, ibid. **6**:405-409, 1946.

8. Barron, L. E., and Curtis, G. M.: Effect of Vagotomy on Gastric Motor Mechanism of Man, Arch. Surg. **34**:1132-1158 (June) 1937.

9. Dragstedt.[1c] Grimson and others.[2] Moore, F. D.; Chapman, W. P.; Schulz, M. D., and Jones, C. M.: Transdiaphragmatic Resection of the Vagus Nerves for Peptic Ulcer, New England J. Med. **234**:241-251, 1946.

Our clinical experience up to this time has led us to the following opinions: 1. The effects of diminished gastric motility on the subjective sensations of the patient have not been sufficiently emphasized in the previous literature. 2. Simple complete section of the vagus nerves performed from below the diaphragm appears to be a satisfactory method of denervation, and if the ill effects of diminished gastric motility are avoided it might follow that the best treatment would be a combination of subtotal gastric resection or gastrojejunostomy [2e] with complete division of the vagus nerves performed at the same time.

SUMMARY AND CONCLUSIONS

Studies before and after operation on a small group of patients submitted to supradiaphragmatic section of the vagus nerves for duodenal or marginal ulcer have demonstrated certain facts which are considered to be of sufficient interest to warrant presentation in a preliminary report: 1. The secretion of gastrc acid in response to alcohol administered intravenously or intragastrically appears to be diminished after section of the vagus nerve. 2. Section of the vagus nerve does not change the electroencephalogrphic pattern of patients with peptic ulcer. 3. Nitrogen balance studies did not indicate any impairment of utilization and absorption of protein as a result of supradiaphragmatic section of the vagus nerve. 4. Diminished gastric motility has been found clinically and roentgenographically. Certain unpleasant symptoms have been attributed to the resultant dilated stomach.

REVIEW OF UROLOGIC SURGERY

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KIDNEY

Congenital Anomaly.—Headings and Palmer [1] report a case of supernumerary kidney with the ureter opening into the vagina in a 24 year old white woman, whose chief complaint was dribbling from the vagina. This makes a total of 44 such cases which have been reported in the literature. In this case successful surgical removal of the small supernumerary kidney with its ureter resulted in eradication of the patient's complaint of dribbling from the vagina.

Carlson [2] states that most supernumerary kidneys are located below the normal kidney and are generally smaller than the normally placed kidney. The ureters show considerable variation. Usually the ureters of the supernumerary and normal kidneys fuse before entering the bladder. Complete reduplication may be present. Ectopic ureteral orifices have also occurred, commonly with openings into the vagina or prostatic urethra. Openings into vaginal cysts or into a blind sac have also been found. In some instances the ureter of the upper kidney opened into the pelvis of the lower kidney. The ureter may be absent.

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1. Headings, D. M., and Palmer, R. E.: Supernumerary Kidney with Ureter Opening into Vagina, Am. J. Surg. **71**:370-373 (March) 1946.

2. Carlson, H. E.: Supernumerary Kidney as a Cause of Uretero-Pelvic Obstruction, J. Urol. **56**:179-182 (Aug.) 1946.

The writer presents a case in which a supernumerary kidney located beneath the ureteropelvic junction had apparently produced obstruction and together with infection resulted in a calculous pyonephrosis which destroyed the normally placed kidney.

Bell [3] states that horseshoe kidney is not a contraindication to pregnancy, although a high percentage of women with horseshoe kidney have a complicated pregnancy or have to have labor induced.

The writer presents a case in which a complicated pregnancy was terminated early; however, the horseshoe kidney was corrected surgically and two subsequent pregnancies were uncomplicated.

Neoplasms.—White and Braunstein [4] state that renal vascular tumors, excluding telangiectasis and varix, may be classified as follows: benign: capillary hemangioma, plexiform hemangioma, cavernous hemangioma; malignant: hemangiosarcoma, hemangioblastoma.

The capillary angioma exists commonly in the form of a small papillomatous lesion projecting into the calices or renal pelvis. The plexiform and cavernous hemangiomas and the hemangiosarcomas may be found in any portion of the kidney, but usually are found directly under the epithelial lining of the calices or pelvis. These tumors may exist as a solitary lesion or may be concomitant with similar lesions elsewhere in the body. They may vary in size from that of a pinhead to several centimeters in diameter. The sex incidence is about equal. In the majority of cases patients are in the fourth and fifth decades of life, but apparently no age is exempt.

The chief diagnostic symptom presents uncontrollable hematuria associated with significant absence of roentgenologic evidence. Pain is present in any degree but is not a constant factor. Occasionally with the larger tumors it may be the first symptom. If the tumor is of long standing and of sufficient size to alter the renal architecture through obstructive phenomena, or is so located as to produce calycectasis or pyelectasis, it may be detected roentgenographically.

Painful hematuria with significant lack of roentgenologic evidence is always suggestive. Intravenous and retrograde urography is absolutely imperative if a diagnosis is to be confirmed. Nephrectomy is the treatment of choice, since all attempts at controlling hematuria by medical or cystoscopic means have proved unsuccessful.

Hill [5] states that up to the present time 35 authentic cases of Wilms's tumor in the adult have been recorded in the literature. Four patients

3. Bell, R.: Horseshoe Kidney in Pregnancy, J. Urol. **56**:159-161 (Aug.) 1946.

4. White, E. W., and Braunstein, L. E.: Cavernous Hemangioma: A Renal Vascular Tumor Requiring Nephrectomy; an Unusual Entity, J. Urol. **56**: 183-189 (Aug.) 1946.

5. Hill, R. M.: Embryoma of the Kidney in the Adult, Brit. J. Urol. **18**: 53-59 (June) 1946.

survived for an appreciable time. A mass in the loin or abdomen, pain and hematuria are the most common symptoms. The writer reports a case in a 35 year old woman who was treated by nephrectomy followed by a course of high voltage roentgen therapy (3,500 r). Five years following operation the patient was in excellent health and there was no evidence of recurrence.

Lasher [6] reports a case in which a hypernephroma was removed from the retroperitoneal tissues outside the kidney. The possible sources of such a neoplasm are discussed. Attention is directed toward the fact that, in general, adrenal rests are found in association with structures derived from the mesonephros or in their paths of descent. Tumors of either hypernephroid or androgenic type may arise from these ectopic islands of adrenal cortex.

Hydronephrosis.—In a series of articles on hydronephrosis, Hinman [7] states that the tubular structure of the kidney has been studied over the years by means of just two methods, reconstruction and teased dissection. Unfortunately, neither method demonstrates satisfactorily the later changes of hydronephrosis and consequently investigators interpret differently the discoveries made by the same method. Many questions may have to remain unanswered unless a newer, more accurate method of demonstrating the changes is discovered.

In the past, descriptions concerning chiefly the changes occurring after complete ureteral obstruction in experimental animals have been confined too closely to tubular changes. Basically hydronephrosis is glomerular, and thus in the pathogenesis of hydronephrosis the vascular changes are no less important than the tubular.

The unit of renal function is not the tubule. It takes a group of glomerulotubules to form such a unit, and this is locked inseparably with blood supply. Conclusions from a study of tubular changes alone are thus incomplete.

In the progression of hydronephrosis, glomeruli remain longest. Because soon different components of the unit cannot be distinguished, the tubular changes are hard to follow microscopically and what has happened to the individual tubules of the surviving glomeruli has long been a matter of conjecture. In man, the variation in the rate of tubular atrophy in different renal portions varies according to the circulatory arrangement. Pressure atrophy is more or less uniform throughout the kidney, but anemic atrophy is not.

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6. Lasher, E. P., Jr.: Primary Extrarenal Hypernephroma: Discussion of Sites and Origins, and a Report of a Case, West. J. Surg. **55**:87-93 (Feb.) 1947.

7. Hinman, F.: Hydronephrosis: I. The Structural Changes, Surgery **17**: 816-835 (June) 1945; II. The Functional Changes, ibid. **17**:836-845 (June) 1945; III. Hydronephrosis and Hypertension, ibid. **17**:845-849 (June) 1945.

One can only surmise what happens when all portions of a tubule have atrophied. The method of maceration and dissection is inadequate for answering the question of whether the glomeruli retain a duct through which their filtrates can drain directly into the pelvis or whether they are completely isolated. Perhaps both of these processes occur.

The corticomedullary line is drawn on both vascular and tubular distinctions. Throughout progressive hydronephrotic atrophy the vascular and tubular distribution above and below this line persists in some form. As the interlobar and arcuate vessels stretch and their calibers diminish with pelvic distention, only those interlobular arteries which have not been shut off by the compression continue supplying blood to their glomeruli. These arteries, through postglomerular capillary plexuses and arteriolae rectae, continue to nourish the corresponding tubular components. This leads to great differences in the rate of progress of hydronephrotic atrophy throughout the parenchyma of the same kidney. This accounts for the group distribution of survival, permitting isolated repair nodules in experimental hydronephrosis. There is considerable difference later in the size of glomeruli, which indicates the possibility of compensatory hypertrophy of some glomeruli in this condition.

Pressure atrophy and anemic atrophy combine to produce hydronephrotic atrophy. Tubular and circulatory changes in this condition are interrelated.

Hydronephrotic atrophy is distinct and separate from primary or any other kind of atrophy. The condition of hydronephrosis presupposes continued secretion of urine in spite of the obstruction. Since many of the structural changes occurring in hydronephrosis are still not understood it is as difficult to correlate structure and function as it is to reconcile normal and hydronephrotic functions.

Experimental and clinical evidence conclusively demonstrates that there are an inflow and an outflow of the contents of a hydronephrotic kidney. Drainage of urine permitting continuation of excretion explains the mechanism of hydronephrotic atrophy. The mechanism of reabsorption in hydronephrosis has not been definitely established, and thereon the main controversy now hinges. A number of pathways of urinary backflow from the renal pelvis have been proved and others suggested. Until the loops of Henle are destroyed, tubular absorption of glomerular filtrate in excess of normal probably occurs. Since the collecting ducts can be filled for a short distance only, pelvic urine would not reach the loops of Henle directly for reabsorption. Physiologic backflow and reabsorption by way of collecting tubules may occur through retrograde distention with transudation into pericanalicular spaces as edema fluid and absorption by capillaries or lymphatics or both. When a pathologic condition is present it may occur through the rupture of

the distended wall of the tubule with extravasation into the capillaries or lymphatics or through slits or both and excavations of the torn papilla into tissue spaces around the collecting tubules.

At the fornix calicis the caliceal or pelvic epithelium joins that covering the papilla and in this transition acquires endothelial properties by which a direct relationship to capillaries, similar to that in glomeruli, is established. Physiologic absorption of total urine may occur at this point without fornical rupture under certain conditions of diuresis or peristalsis, the fluid passing either directly into the veins or after marked extravasation into capillaries or lymphatics. In the pathologic state, multiple fornical ruptures occur which would permit urine to pass either directly into the veins or into the tissue spaces with flow into veins or lymphatics. This mechanism cannot be effective after the third week of obstruction, however, since at that time the fornices have disappeared and the interstitial spaces are being filled progressively with newly formed connective tissue.

At this period, because irregular damage to the glomeruli has occurred, some glomeruli are working with a higher filtration pressure than are others. A sufficient difference in blood pressure in two major groups of glomeruli may cause back filtration of the filtrate of the high pressure glomeruli into the low pressure glomeruli. The flow of urine thus does not cease. The eventual destruction of the glomeruli is paralleled by a diminution of this flow.

Some insight into the mechanics of hydronephrosis is obtained by studying blood flow and secretory pressure. Ureteral ligation or partial obstruction of the renal artery or both lower these factors and together speed up the process of hydronephrotic atrophy. Neither prolonged polyuria, in which both these factors are increased, nor prolonged oliguria has effect on the rate of progress of the atrophy. Increased activity of a kidney with a ligated ureter has no effect on the rate of development of hydronephrosis. Unilateral oliguria per se has so far been beyond experimental tests.

Hypertension has two possible connections with hydronephrosis. Sometimes it might be an accelerator; at other times, an effect. Experimental and clinical studies show that high blood pressure has no influence on the mechanics of hydronephrosis.

The changes of hydronephrosis could well have an effect on blood pressure. The factors supposedly responsible for hydronephrotic atrophy could act to promote renal hypertension. Renal ischemia, however, is not the essential factor, as was formerly thought. It is not yet known how constriction of a renal artery causes hypertension. All attempts to produce permanent hypertension by the simple ligation of one ureter have been unsuccessful. Clinically, hypertension is an unexpected complication in simple hydronephrosis. The renal origin of hypertension, it is seen, is very uncertain.

Renal hypertension appears to depend on the ratio of ischemic to normal renal tissue. In hydronephrosis both of these factors are affected. The magnitude and course of any resulting hypertension depend on the amount of renal ischemia and on the amount of hydronephrotic atrophy of the normal renal parenchyma, as well as on the compensatory increase in normal renal tissue in the opposite kidney. Just as in renal arterial constriction, so is it possible that in hydronephrosis renal excretory insufficiency may develop without the occurrence of hypertension if the decrease in normal parenchyma is inordinately greater than the amount of ischemic renal tissue. In such an event the process leads primarily to destruction of normal renal tissue and this may become great enough to simulate complete nephrectomy. These considerations give little encouragement for the cure by nephrectomy of hypertension occurring in unilateral hydronephrosis.

The attempt to repair every hydronephrotic kidney not entirely destroyed is not only without a common sense basis but may be actually dangerous. The surgical repair may itself so alter the mediators of blood pressure as to cause hypertension later on. A case is cited in which hypertension with symptoms occurred five years following a successful plastic repair and nephropexy of an uninfected hydronephrotic kidney. The renal function had remained the same over the five year period, and there was no evidence of there having been urinary infection during this time. Cure was effected following nephrectomy.

Hypertension is somewhat more common in the presence of bilateral hydronephrosis. The age of the patient may be a factor in the incidence of hypertension in both unilateral and bilateral hydronephrosis. Compensatory hypertrophy is much less marked in older persons and is almost absent in the bilateral condition. Again, it is possible that the kidneys may be only one of many factors causing essential hypertension.

Cases of hydronephrosis studied over a four year period at the University of California Hospital are reviewed. Nephrectomy offered little benefit as regards hypertension in this series.

Owing to the principle of compensatory hypertrophy, a hydronephrotic kidney, as well as its mate, is overstimulated. This is the reason that some units, during certain stages of hydronephrotic atrophy, show hypertrophy or at least are kept more active and resistant. It is also the reason for the rarity of hypertension with hydronephrosis. This overstimulation due to hydronephrosis will disappear, however, when the mate has fully compensated by hypertrophy to carry the overload.

Miscellaneous.—Abeshouse and Tankin [8] state that administration of any of the common sulfonamide drugs, such as sulfanilamide, sulfa-

8. Abeshouse, B. S., and Tankin, L. H.: Renal Complications of Sulfonamide Therapy, J. Urol. **56**:658-687 (Dec.) 1946.

pyridine, sulfathiazole, sulfadiazine or sulfamerazine, may be complicated by toxic and irritative lesions of the upper part of the urinary tract.

The toxic manifestations of such renal complications are: (*a*) crystalluria, (*b*) hematuria, (*c*) oliguria or anuria, (*d*) azotemia, (*e*) renal or abdominal pain (*f*) tenderness over the kidneys and ureters, (*g*) enlargement of the kidney and (*h*) albuminuria.

The pathologic changes produced in the kidneys of experimental animals and in human beings after prolonged administration or overdosage of sulfonamide drugs are of two types; namely (*a*) mechanical changes caused by the deposition of crystals or concretions in the renal tubules, pelvis or ureters and (*b*) chemical changes, such as acute toxic and degenerative nephritis (calcifying nephrosis). The renal complications are the result of the poor solubility of these drugs and their acetyl derivatives. Experimental and clinical studies show that the incidence of these complications is directly related to the solubility of the drug. Renal complications rarely are observed following administration of sulfanilamide, a relatively soluble drug, but frequently are noted following administration of sulfapyridine, sulfathiazole, sulfadiazine and sulfamerazine, which are relatively insoluble drugs.

The chief factors influencing precipitation of the crystals and formation of sulfonamide concretions are (*a*) concentration of the drug in the urine, (*b*) degree of acetylation or conjugation of the drug, (*c*) the presence of an obstructive or inflammatory lesion in the upper part of the urinary tract, (*d*) p_H of the urine and (*e*) temperature of the urine.

Crystalluria per se is not an indication of serious renal damage and can be remedied by temporarily withdrawing the drug or decreasing the dosage, forcing fluids and alkalinizing the urine adequately.

Every patient receiving sulfonamide drugs should be under close and constant surveillance for any toxic renal complication, such as hematuria, oliguria or anuria, azotemia or renal or abdominal pain. The occurrence of any one or more of these symptoms demands immediate withdrawal of the drug and the prompt institution of corrective measures.

The occurrence of these complications can be prevented or their incidence can be reduced by adopting the following precautions: (*a*) determining previous sulfonamide medication, drug sensitivity or idiosyncrasy, (*b*) determining renal function before and during drug therapy, (*c*) careful evaluation of state of hydration (water balance), (*d*) administration of drug in accurate dosage to avoid overdosage and (*e*) adequate alkalinization to sustain a p_H of the urine of 7.6.

In cases of anuria complicating sulfonamide therapy, it may be necessary to employ cystoscopy and ureteral catheterization to distinguish between the mechanical type (obstruction of ureters or pelves

by crystals or concretions) and the chemical type (acute toxic and degenerative nephritis).

When the usual corrective measures—increased intake of fluid, alkalinization, ureteral catheterization—fail to improve or restore renal function, it may be necessary to resort to operative methods to prevent uremia.

Decapsulation alone or in combination with pyelostomy or nephrostomy or retrograde ureteral catheterization has proved to be lifesaving in otherwise hopeless instances.

In 1 case of anuria following sulfadiazine therapy in which the condition failed to respond to the usual conservative measures (including ureteral catheterization) and to decapsulation with nephrostomy, at necropsy evidence of thrombosis of both renal arteries was observed. This complication has not been previously described or reported.

Munger [9] makes a plea for a more conservative attitude in renal surgery. He states that too many nephrectomies are performed. The surgical correction of hydronephrosis is, for the most part, a perfectly logical and feasible operation. Hydronephrosis is commonly a bilateral disease. Protective splinting with adequate and prolonged intrapelvic drainage is an absolutely necessary procedure in plastic correction of the renal pelvis. About 70 per cent of diseases requiring surgical intervention and of congenital malformation of the kidney are amenable to partial nephrectomy. Total nephrectomy in hydronephrosis should be instituted only when it can be demonstrated that the drainage system is completely destroyed beyond recovery and in renal disease wherein it can be shown that the kidney is utterly worthless.

Ratliff, Nesbit, Plumb and Bohne [10] report the results of urologic studies of 2,055 hypertensive patients. One hundred and eighty-three lesions were found. Hypertension may coexist with any of the common renal lesions, but there is no consistent relationship between hypertension and any particular gross renal lesion. Congenital absence of a kidney, reduplication of pelvis and bilateral lesions occurred in 70 of the cases. Patients in the remaining 113 cases had unilateral lesions. Nine per cent of all the patients studied had renal abnormalities, while less than 5 per cent were candidates for nephrectomy and fewer came to operation.

During the eleven year period (1934 to 1945) in the records of the University of Michigan Hospital 49 cases of severe hypertension treated by nephrectomy were found. In all but 7 of these the systolic

9. Munger, A. D.: A Plea for a More Conservative Attitude in Renal Surgery, J. A. M. A. **132**:675-679 (Nov.) 1946.

10. Ratliff, R. K.; Nesbit, R. M.; Plumb, R. T., and Bohne, W.: Nephrectomy for Hypertension with Unilateral Renal Disease: Report of Forty-Nine Cases, J. A. M. A. **133**:296-299 (Feb. 1) 1947.

pressure was well over 200 or the diastolic over 100. The follow-up period has been longer than twelve months in all but 8 of these cases. Seventeen patients (34.6 per cent) were considered to have had good results, and 6 (12.4 per cent) were improved; results in 26 cases (53.0 per cent) were failures. In cases in which the results were good the patient was free from hypertensive symptoms and had a normal blood pressure at the time of the last follow-up report. In other words, the patient was considered cured according to clinical evidence at the date of check-up examination. Results were regarded as a failure when a patient was not improved by nephrectomy or subsequently died as the result of hypertension.

The authors concluded that when unilateral renal disease is demonstrated by roentgenologic examination it can be treated by nephrectomy, with an expectation of improvement or cure of the associated hypertension in about half of the cases. In their series of cases the greatest incidence of favorable results occurred in the cases of chronic pyelonephritis in adults, hydronephrosis and calculous pyonephrosis. In the group of cases of "infantile chronic pyelonephritis," the incidence of cure was definitely less than that in adults.

The higher percentage of cures falls in that group of patients who have gross urologic symptoms. Fewer good results followed nephrectomy in the group of hypertensive patients who had no urinary symptoms.

Wagner [11] presents a modified technic of abdominal arteriography, featuring use of a hand syringe for injection instead of the pressure apparatus. Advantages of the hand syringe method are its simplicity and greater protection against extravasation by allowing detection of change in resistance during injection.

Visualization of the renal artery and its branches is best when the needle is introduced one vertebral level below the classic site.

The difficulties and potential dangers of the procedure can be minimized by a competent team.

One normal and two abnormal arteriograms are presented and interpreted.

Kleiman [12] reports a case of anuria due to sulfathiazole with recovery following renal decapsulation.

The patient was a white man, aged 56 years, who had received 14 grains (0.91 Gm.) sulfathiazole three times a day for seven days, and then 14 grains of sulfathiazole at four hour intervals for two days. Almost complete anuria developed; the urinary output decreased to 45 cc. per twenty-four hours.

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11. Wagner, F. B.: Arteriography in Renal Diagnosis: Preliminary Report and Critical Evaluation, J. Urol. **56**:625-635 (Dec.) 1946.

12. Kleiman, A. H.: Sulfathiazole Anuria with Recovery Following Renal Decapsulation, J. Urol. **56**:598-601 (Nov.) 1946.

Difficulty was encountered with the family in regard to operation; finally permission was granted for unilateral decapsulation, which was done five days after complications developed.

The routine incision in the left loin was made. The perinephric tissues were very edematous and oozed serous material freely. The renal mass with its surrounding perinephric fat resembled a supersaturated sponge. The kidney was enlarged to about one to three fourths times its normal size. It was very turgid. The capsule was under undue strain. When it was nicked, the kidney practically decapsulated itself. Decapsulation was carried down to the renal pedicle and was complete.

On the evening following operation, the patient voided 580 cc. On the second postoperative day, the twenty-four hour output was 1,005 cc. Blood urea on the fifth day was 48 mg., whereas it had been 90 mg. before operation. Intravenous pylegrams showed excellent concentration and elimination of contrast medium in five minutes from the left kidney. The right kidney failed to concentrate dye in thirty minutes sixteen days postoperatively. When cystoscopy was performed on the twenty-third postoperative day, indigo carmine was injected and appeared in excellent concentration in five minutes from the left kidney. It failed to appear in one hour from the right kidney.

This case is a typical one of sensitivity to sulfathiazole. A complete genitourinary examination failed to reveal any evidence of sulfathiazole crystals, either in the urine itself or in the upper part of the genitourinary tract. The edematous, cyanotic appearance of the kidney would lead one to suspect that a markedly toxic reaction had occurred within the renal parenchyma.

URETERS

Traumatic Injuries.—Herman, Greene and Hayllar [13] have reviewed the literature of the past ten years on the subject of ureteral injury. The fact that fifty-eight papers were found led them to believe that the subject has been well covered and that ureteral injury is a common occurrence.

Ureteral injuries may be classified under three general headings, on the basis of the causative factor: (1) external violence, (2) spontaneous rupture and (3) instrumental injuries and surgical trauma.

Ureteral injury from external violence is unusual in civilian practice, but serious injuries may result from pelvic fractures. Even in military surgery comparatively few instances of ureteral injury have been reported.

Spontaneous rupture of the normal ureter is extremely rare. Spontaneous rupture of the diseased ureter, usually at the site of an impacted calculus, is not unusual. Spontaneous rupture of the abdominal segment of the ureter occurred at the site of previous ureterolithotomy when a stone became impacted below this point. The patient was a man aged 60 years. A urinary fistula persisted after incision and

13. Herman, L.; Greene, L. B., and Hayllar, B. L.: Ureteral Injuries, J. Urol. **56**:688-696 (Dec.) 1946.

drainage of the abscess, until a practically functionless and badly infected kidney was removed.

Instrumental perforation or rupture of the normal ureter is most unusual, since this structure is highly resistant to perforation by the ureteral catheter. Mild contusions and lacerations are common enough, and the sequelae are well known to every practicing urologist. While stricture may conceivably result from such trauma, the probabilities are that little permanent damage results.

Periureteral abscesses often occur spontaneously at the site of long-impacted stones, but not always as the result of actual perforation with urinary extravasation; in fact, the kidney may be functionless.

Catheter perforation of the ureter, even if followed by periureteral injection of methiodol sodium ("skiodan"), may cause no inconvenience.

Surgical injuries to the ureter occur more frequently in gynecologic operations than in other surgical procedures because of the anatomic relationship of the ureter to the pelvic organs of the female and the difficulty involved in dissection when complications are present. That portion of the ureter which passes through the broad ligament is the most vulnerable.

In the women's clinic at the Pennsylvania Hospital during the period from 1936 to 1945 there were four injuries to the ureter in a total of 7,966 gynecologic operations. No injury to the ureter was recognized during the same period in a series of 15,325 deliveries, which includes 1,568 cesarean sections.

Injury to the ureter may go unrecognized, especially if it is ligation of a ureter. Ureterovaginal fistula may result.

The ureter may be severed during resection of the bladder or diverticulectomy. The injury is usually treated by ligation or reimplantation of the ureter into the bladder. Reimplantation seemed to prolong the life of 1 patient whose opposite kidney was destroyed later by calculous pyonephrosis.

BLADDER

Rupture.—Fiegal and Polzak [14] report 3 cases of spontaneous rupture of the urinary bladder. They state that the most important cause of spontaneous rupture of the bladder is overdistention, on the basis either of prostatic enlargement or urethral stricture. The fuller the bladder, the more likely it is to rupture. Neurogenic dysfunction may also account for some of the cases of overdistention. Alcohol, by dulling the sensorium, delays the urge to void and tends to produce overdistention. Because of this, alcohol is frequently an important etiologic factor in rupture of the bladder, whether spontaneous or traumatic.

14. Fiegal, W. M., and Polzak, J. A.: Spontaneous Rupture of the Urinary Bladder, J. Urol. **56**:196-199 (Aug.) 1946.

Long-standing distention with resultant degeneration of the vesical wall and pathologic changes in the wall produced by neoplastic or inflammatory disease also play a role in the production of spontaneous rupture. The rupture is almost invariably intraperitoneal. The patient commonly experiences severe abdominal pain followed by dysuria and urgency. Very frequently he voids a small quantity of grossly bloody urine, after which complete retention is present. The abdomen is usually rigid and tender and frequently a fluid wave and shifting dulness to percussion can be elicited. Hiccups may be present; vomiting and nausea are often prominent symptoms. Leukocytosis with a relative increase in the number of polymorphonuclear cells is noticed almost invariably.

Spontaneous rupture of the urinary bladder is an acute surgical emergency. Laparotomy with aspiration of intraperitoneal fluid, closure of the rent and adequate drainage of the bladder will reduce the mortality and morbidity. Use of penicillin, sulfonamide drugs and care in choice of anesthetic will further improve the prognosis.

Inflammatory Conditions.—Moulder [15] presents a case of thrush of the urinary bladder and discusses the condition. He states that the lesions are soft pearly white slightly elevated patches which resemble deposits of coagulated milk, but they adhere firmly so that the mucosa bleeds when they are removed. Scrapings of the affected parts reveal the filaments and the yeastlike cells.

The case presented is that of a 26 year old white soldier who had experienced attacks of urinary frequency, both nocturnal and diurnal, for eight years. At times frequency and urgency would become intense, and occasionally there was gross hematuria. A constant feeling of discomfort was present in the vesical and perineal regions. Urinalysis showed a cloudy, yellow specimen, p_H 5, specific gravity 1.022, trace of albumin, no sugar, 12 to 15 erythrocytes per high power field and 100 leukocytes per high power field. Culture of the urine on Sept. 11, 1944, revealed many colonies of nonhemolytic Staphylococcus albus and many colonies of fungus similar to Monilia albicans. All subsequent examinations of cultures of urine revealed essentially the same findings except that on October 11 and 20 pure cultures of Monilia albicans were isolated under strictly sterile conditions. At cystoscopy a 24 Brown-Buerger cystoscope was passed easily to the bladder. The capacity was 160 cc. The mucosa was involved in a diffuse rather intense inflammatory reaction, the mucosa itself appearing red and slick, but no vessels were prominent except over the trigone. Located just medial to the left ureteral orifice and just above to the left in the bas-fond and up toward the dome of the bladder there were three distinct slightly elevated, white irregular patches measuring about 1 by 2 cm. in diameter. They appeared to be firmly attached to the underlying mucosa. The ureteral orifices appeared normal except for the minor edema of diffuse cystitis. The posterior and anterior parts of the

15. Moulder, M. K.: Thrush of the Urinary Bladder: Case Report, J. Urol. **56**:420-426 (Oct.) 1946.

urethra appeared normal and were not involved in any ulcerative process. A 6 F. catheter was passed easily to each kidney, and clear urine flowed freely from each side. Renal function test with indigo carmine revealed prompt appearance and a 4 plus secretion of the dye. Retrograde pyelograms revealed that the upper part of the urinary tract was normal. On differential count 1 or 2 leukocytes and an occasional erythrocyte from each renal pelvis were found. Neither pyogenic nor yeast organisms were found on culture.

The patient was treated with penicillin, irrigations of the bladder with silver nitrate solution and with solution of gentian violet fulguration of the lesions and repeated courses of administration of sulfathiazole during a period of nine months, at the end of which time the urine was normal and the vesical mucosa was observed to be normal on cystoscopic examination. Sulfathiazole was apparently the most effective of the various therapeutic measures used.

Crance [16] discusses grain mite infection of the urinary tract and reports 3 cases. Grain mites are sporozoa and are encountered in myriads in foodstuffs which are beginning to ferment. They are particularly abundant in different kinds of cheese such as Parmesan, Cheddar, Gruyère and Dutch cheese. They may be found in the eyes of the cheese but are sometimes present under the crust, in which they dig innumerable tunnels. They abound in flour and bread. They may therefore be carried to the digestive system of man with his food and may be found during microscopic examination of the stools.

Crance states that, in looking for the grain mite (Tyroglyphus longior) in the urine, the specimen must be centrifuged several minutes at high speed. It may even be necessary to centrifuge several specimens, and it is preferable to use the sediment after a specimen has stood in a conical glass. When looking for the mite, using the low lower lens (and the grain mite is easily seen under low power), one is impressed by the fact that the epithelial cells and the occasional pus cells and other debris occasionally show a motion different from that noticed on examination of a wet smear, when everything moves in one direction. Urinary debris and so forth in this instance do not seem to move in the same direction. This should make one suspicious that a grain mite is working in the neighborhood. The slide should then be moved carefully toward the point where this motion seems to be originating. When one is successful in finding it there is no doubt whatsoever as to its identity. The mite will be found moving forward slowly in a side to side, lobster-like fashion with his claws busy opening and closing. Careful focusing will reveal the six tails projecting out from the stern. These tails are close together.

Symptoms of the infection consist of frequency of micturition, urgency and nocturia, often of severe degree.

The portal of entry is probably through direct contact of infected fecal material with the urethra. However, in the male this is hardly

16. Crance, A. M.: Grain Mite Infestation of the Urinary Tract: Report of Three Cases, J. Urol. **56**:588-593 (Nov.) 1946.

possible. Possibly the eggs reach the bladder through the kidney and ureters, and hatch after implanting themselves on the vesical wall.

In the 3 cases reported treatment consisting of irrigations of the bladder and instillation of 20 per cent solution of mild protein silver ("argyrol") was rapidly successful.

Tahara, Lechner and Hess [17] report 3 cases and discuss the manifestations and treatment of a condition which they feel is a new clinical entity. The condition is characterized by symptoms of marked urinary frequency, stranguria, gross hematuria, a small contracted bladder and dilatation of the ureters from the intramural portion up to and involving the pelvis and calices of both kidneys. They have named the disease "acute interstitial cystitis" and feel that it is an acute inflammation of the muscularis of the vesical wall.

The patients were young males and the condition apparently began with a mild to moderately severe form of urethritis or prostatitis which responded initially to treatment with sulfathiazole or penicillin only to be followed (in three weeks in 2 cases and nine months in the other case) by the more severe vesical symptoms of acute interstitial cystitis. The prognosis is good; treatment with large doses of penicillin was effective. Neoarsphenamine also was used in the 3 cases reported. The writers feel that the diagnosis of this condition can be made from the history and intravenous urograms and that instrumentation should not be used.

Neoplasms.—Ockuly and Helwig [18] report a case of endometriosis of the urinary bladder in a 26 year old woman who had experienced symptoms of abdominal pain and frequency of urination for five years. These symptoms were aggravated during menstruation, gradually subsided following it and were minimal immediately prior to the period. Cystoscopic examination showed a mass approximately 4 cm. in diameter on the posterior wall of the bladder near the dome and to the left of the midline. The tumor was slightly raised and was covered with short, fine villi, between which an occasional minute, translucent cyst could be seen. The tumor disappeared in several weeks after roentgen therapy. Ockuly and Helwig state that endometriosis of the bladder is varied in symptoms, physical findings and even gross and microscopic appearance depending on the extent of involvement of the wall of the bladder and the stage of the menstrual cycle. Vaginal, cystoscopic and urinary findings may be entirely lacking in the early stages of the disease.

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17. Tahara, C.; Lechner, C., and Hess, E.: Acute Interstitial Cystitis: A Clinical Entity, J. Urol. **56**:535-543 (Nov.) 1946.

18. Ockuly, E. A., and Helwig, F. C.: Endometriosis of the Urinary Bladder with Report of a Case, J. Urol. **55**:464-469 (May) 1946.

Melicow [19] states that the correct interpretation of a biopsy of the bladder is contingent on the cooperation of urologist, technician and pathologist.

He states that because of the behavior of vesical tumors, the value of a biopsy of the bladder is limited because: (*a*) complete eradication of a benign tumor does not necessarily mean cure because new tumors may develop subsequently; (*b*) the cell population of a vesical tumor is not always uniform; changes characteristic of malignancy are likely to occur at or near the base and are often inaccessible to the biopsy forceps, and the biopsy, therefore, may or may not be representative of the remainder of the tumor.

The grading of vesical neoplasms is of value for statistical and pathologic studies, and as a shorthand description of a tumor.

Physical factors, size, breadth of the base, the presence of infiltration and extramural involvement of the bladder, as well as the findings at biopsy, should guide treatment and prognosis.

Milner [20] discusses treatment of carcinoma of the bladder for the past five years with special reference to the closed method of treatment. For the purpose of simplicity he divided carcinoma of the bladder into two main groups, namely, papillary carcinoma and epidermoid carcinoma. In the first group he has placed all papillary growths, non-infiltrating and infiltrating. In the second he has placed the solid sessile "meaty" types of tumor, most of which, of course, are infiltrating. For this paper he has collected 245 cases in which operation was performed on the urologic service at the Albany Hospital from 1940 to 1945. Of these 245 patients 188, or 76.7 per cent, have been accurately followed; 57, or 23.3 per cent, could not be traced and for them no record is available.

The average age of the 245 patients was 62.9 years. Sixty-five patients, or 26.5 per cent, were females; 180, or 73.5 per cent, were males. One of the most startling revelations of the analysis was that, on the average, twelve and one-half months elapsed from the time the patient had his first vesical symptoms until he presented himself for diagnosis and treatment. Hematuria, usually periodic, was the outstanding initial symptom in 230 cases, or 94 per cent. The diagnosis was established or confirmed in every instance by cystoscopic examination. Not a few tumors were demonstrated by a cystogram made as a part of intravenous pyelography. Of these patients 229, or 93 per

19. Melicow, M. M.: The Bladder Biopsy: An Evaluation of the Cystoscopic Procedure, J. Urol. **56**:339-348 (Sept.) 1946.

20. Milner, W. A.: Treatment of Carcinoma of the Bladder for the Past Five Years with Special Reference to the Closed Method Treatment, J. Urol. **55**: 607-612 (June) 1946.

cent, were treated by the closed method exclusively, namely, transurethral resection of the tumor down to and exposing the muscle layer of the bladder wherever the depth of infiltration did not make this impossible. The base of the tumor was then fulgurated. Resection should be carried out so as to remove at least ⅛ inch (0.32 cm.) of what appears to be normal mucosa surrounding the base of the tumor itself. The actual size of the tumor should not always be a contraindication to transurethral resection even though it might be easier for the surgeon to perform cystotomy. Three patients had tumors which weighed more than 100 Gm.

Cases are selected for radium implantation on the basis of the evidence of infiltration seen at preliminary cystoscopy. Milner states the belief that the lessened morbidity accompanying transurethral implantation of radon seeds more than makes up for the greater accuracy obtained by opening the bladder. For high voltage roentgen therapy 4,000 or 5,000 r are given through three portals. High voltage roentgen therapy is employed only in cases of infiltrating tumor in which some extra help is felt necessary. Milner uses it routinely in cases of multiple papillary carcinoma, grade 1, for he feels that it tends to reduce the possibility of recurrence in these cases. In no instance of multiple tumors has the high voltage therapy entirely prevented recurrence, but he feels that the degree of recurrence has been less. Some noninfiltrating carcinomas require neither of these last two procedures.

Partial cystectomy or segmental resection of the part of the bladder involved was performed in 15 cases.

Total cystectomy with transplantation of the ureters to the intestine was carried out in 3 cases. One patient was a poor risk and was operated on largely for relief of intractable pain. The other 2 died as the result of metastasis, 1 two years and 1 twelve months postoperatively. Neither of the tumors in the last 2 cases showed any signs of extension preoperatively or at operation. In 93 cases, or 38.7 per cent, the tumor was an epidermoid carcinoma; in 145 cases, or 60.4 per cent, papillary carcinoma; in 1 case, or 0.4 per cent, malignant melanoma. Ninety, or 37.5 per cent, were grade 3 and 4 tumors; 150, or 63.5 per cent, were grade 1 and 2 tumors; 163, or 67.8 per cent, were definitely malignant according to the microscopic diagnosis; 75, or 32.2 per cent, were grade 1 tumors. The operative mortality rate was as follows: total cystectomy, 33.3 per cent (1 patient of 3); partial cystectomy, 6.7 per cent (1 patient of 15), and transurethral resection, 0.4 per cent (1 patient of 225). Of the 189 patients concerning whom definite information is available 71 patients, or 37.6 per cent, are known to be dead; 61 patients, 2 of whom were moribund on admission and

could not be operated on, or 32.3 per cent, died as a result of their disease and 10 patients died from other causes but were free from tumor. Transurethral resection has effected cure in a good number of cases up to three and four years. The results for segmental resections have been somewhat more disappointing than Milner expected, in view of the care with which these patients have been selected for operation. Results from total cystectomy have been uniformly bad; 3 patients were operated on and no cures were accomplished. This, however, in Milner's opinion, is not the fault of the operation but rather of the selection of cases.

Barnes, Turner and Bergman [21] state that tumors of the bladder more than 5 cm. in diameter and those situated in the ventral portion of the dome of the bladder should be removed at open operation; otherwise endoscopic electrosection and fulguration are the methods of choice. A thorough removal of tumor tissue can be accomplished through the endoscopic approach because the tissue can be examined minutely and thoroughly through the lens system of the instrument, and a distinction between tumor tissue and vesical muscular tissue can be made. From this observation it can be determined whether all the tumor tissue has been removed. There is danger of cutting entirely through the vesical wall, and extravasation of urine into perivesical tissues may result when the endoscopic approach is used, but the danger is minimized when the surgeon is familiar with the difference in appearance of the tissues.

During the past five years the authors have been using radon emanation seeds implanted into the area where the tumor previously was after endoscopic electrosection and fulguration for treatment of lesions of grade 2 or more of malignancy. The usual time of implantation of the seeds is four weeks after resection and fulguration of the growth. By this time most of the desiccated tissue has sloughed away, and a deeper, more accurate implant is possible. One and five-tenths millicurie seeds are placed about 0.5 cm. apart throughout the tumor-bearing area of the vesical wall and are embedded about 1 cm. deep. In most cases the implantation is done through the cystoscope, and if this is performed correctly it is as accurate as when the open suprapubic approach is used.

In the authors' series of 349 cases of tumor of the bladder, there was a significant difference between results of electrosection and fulguration without implantation of radon emanation seeds and this mode of treatment plus implantation of radon. Patients in the group of 122 cases in which radon was used have a longer life expectancy,

21. Barnes, R. W.; Turner, C. L., and Bergman, R. T.: Treatment of Bladder Tumors, California Med. **65**:95-98 (Sept.) 1946.

and the results of treatment are superior to those obtained in the group of cases in which it was not used.

The study also shows that the higher the grade of malignancy of the vesical tumor, the poorer the prognosis, and that in general the results of the use of radon seeds in the more malignant tumors are not as good as when used in the grade 2 tumors.

Muellner [22] states that cancer within a diverticulum of the bladder cannot be looked on as a rarity and must be regarded as a possible menace in all cases of large diverticula of the bladder. This point needs to be stressed, since in most cases the cancer within the diverticulum produces no specific symptoms whatever. Hematuria which is predominantly associated with it usually is explained erroneously on the basis of associated prostatism or infection. The cavity of a large diverticulum cannot be explored by cystoscopic means. Moreover, cystograms only rarely reveal cancer thus situated. In most instances, therefore, the cancer within the diverticulum can be discovered only by digital exploration when the bladder is opened surgically. A safe course is to explore surgically all large diverticula of the bladder, to excise them whether they are found to be free of tumor or not and to deal with the obstructing prostate by means which suit the individual surgeon best. In this manner, tumor-bearing diverticula are dealt with early and the insidious and eventual development of cancer within them is prevented.

Wilhelm [23] reviews 15 consecutive cases in which total cystectomy was performed. There were no operative deaths.

In the first 8 cases operation was done through a suprapubic abdominal incision with bilateral cutaneous ureterostomy in one stage. None of these patients lived much more than two years, nor did any lead a comfortable life after this operation. Three who died had distant metastasis or residual neoplasm in the stump of the prostate and urethra; 5 died as the result of renal infection and uremia.

In operation on 6 male patients the combined perineoabdominal method with implantation of the ureters into the sigmoid colon was used. Five of the men were living comfortably and were able to void through the rectum with normal control when the report was made. The 1 remaining patient, who had an advanced carcinoma, survived the operations but died five months later as the result of a large residual carcinoma.

The operation is done in two stages: at the first, the right ureter is implanted extraperitoneally into the sigmoid colon; at the second stage,

22. Muellner, S. R.: Cancer in Diverticulum of the Bladder: A Pitfall to the Resectionist, J. Urol. **56**:427-428 (Oct.) 1946.

23. Wilhelm, S. F.: Total Cystectomy by the Combined Perineoabdominal Method, Surg., Gynec. & Obst. **84**:90-96 (Jan.) 1947.

the bladder, seminal vesicles, prostate and posterior portion of the urethra are removed in one piece through a combined perineoabdominal incision, and the left ureter is implanted extraperitoneally into the sigmoid colon.

In males, preliminary mobilization of the urethra, prostate and vesical neck through the perineal incision simplifies greatly the subsequent suprapubic excision of the bladder.

The combined perineoabdominal method of total cystectomy is recommended for use in cases of infiltrating carcinoma of the vesical neck and trigone in which the patients are men because it permits truly radical excision of the bladder together with the attached posterior urethra, the entire prostate and the seminal vesicles.

Kleiman [24] discusses massive bladder implants resulting from carcinoma of the renal pelvis and reports a case.

The patient in his case was a man aged 50 years who had undergone nephrectomy on the left side and subsequent high voltage roentgen therapy two years earlier for treatment of a tumor. Ureterectomy was not performed. The large tumor had obstructed the renal pelvis and microscopically had been found to be papillary carcinoma.

On cystoscopy a large villiform papillary infiltrating tumor was noted. It extended from the left trigone and post-trigonal region to the internal urethral orifice and invaded well beyond the midline. A complete cystectomy was performed. The prostate, seminal vesicles, vas deferens and ureteral stump were also removed. No evidence of any extension from the bladder into neighboring structures was found. The entire mucosa of the bladder was involved by numerous papillary, cauliflower-like growths comprised of firm gray tissue. Its wall showed evidence of extensive infiltration and in places measured up to 1.8 cm. in thickness.

Tumors of the renal pelvis occur much less frequently than those in the parenchyma. The former are usually malignant, and pathologically resemble tumors of the bladder or ureter. Most commonly they arise in the mucous membrane of the pelvis and calices. These comprise the papillary and nonpapillary epithelial tumors.

Nonpapillary tumors of the renal pelvis occur less commonly than papillary tumors. The squamous tumor predominates and is the most malignant tumor of the renal pelvis. The tumor is usually firm and large and shows a tendency toward early invasion of surrounding structures. Frequently there is direct extension to the vena cava and regional lymph nodes with metastasis to the lungs, bones, peritoneum and spinal column. It is often associated with calculi, ulceration and

24. Kleiman, A. H.: Massive Bladder Implants Resulting from Carcinoma of the Renal Pelvis, J. Urol. **56**:644-651 (Dec.) 1946.

chronic infection. Hematuria, the most frequent symptom, may or may not be associated with passage of blood clots. Papillary growth tends to bleed sooner than the less vascular infiltrating tumors.

The treatment of choice for papillary carcinoma of the renal pelvis is complete nephroureterectomy including excision of the vesical wall adjacent to ureteral meatus. Papillary tumors of the renal pelvis have a great tendency to recur in the bladder following partial nephrectomy.

The prognosis is particularly unfavorable when the renal parenchyma and perirenal fat are involved. In cases of nonpapillary tumors, whether operation is performed or not, the patient usually dies within a year. The scirrhous type of carcinoma metastasizes early and offers a grave prognosis. The papillary tumors offer the best prognosis if diagnosed early, providing complete nephroureterectomy is performed.

Neurogenic Changes.—Mullenix [25] reports on the use of cystometry and states that it has been of great value in outlining management in a large number of cases of neurogenic bladder due to wounds of the spinal cord and cauda equina. He states that repeated cystometric study is the most important diagnostic aid in the urologic study of the neurogenic bladder and it provides a permanent graphic record of progress over a period of time. By Mullenix' technic of cystometry the passive resting pressure and the active voiding pressure respectively for each hundred cubic centimeters of increment to contents of the bladder is recorded. He thereby obtains a graph displaying the difference between active and passive pressures which represents the expulsive force; this difference is shown by a third curve on the graph called the voiding potential. He found that in those cases presenting a wide difference between the passive and active pressures patients usually were able to void, while in those in which the passive pressure approached, and occasionally equaled, the active pressure patients were never able to void. Thus a choice between performing cystostomy early and leaving an indwelling urethral catheter in place for a time is made more easily.

Bumpus, Nourse and Thompson [26] report the urologic complications observed in 101 cases of injury or disease of the spinal cord occurring among United States Navy personnel.

The most frequent urologic complication of injury of the spinal cord is the so-called cord bladder. In 56 cases this vesical dysfunction followed gunshot or shrapnel wounds. In 34 it resulted from fractures of the spinal column. Among 11 other cases, the vesical paralysis was the result of tumors of the spinal cord in 2, followed inflammatory disease

25. Mullenix, R. B.: Cystometry in the Study of Traumatic Neurogenic Bladder, J. Urol. **55**:470-482 (May) 1946.

26. Bumpus, H. C., Jr.; Nourse, M. H., and Thompson, G. J.: Urologic Complications in Injury of the Spinal Cord, J. A. M. A. **133**:366-369 (Feb. 8) 1947.

in 5, developed insidiously after the patient had spent eighteen months in a Japanese concentration camp in 1 (probably from a dietary deficiency), was associated with myelodysplasia in 1 and a protruding intervertebral disk in another and was the aftermath of spinal anesthesia in 1.

The height of the lesion in the cord has a distinct bearing on the urologic complications. Lesions above the conus medullaris, where physiologists and neurologists consider the mechanism of the bladder reflex to be (anatomists consider the mechanism to be close to the eleventh and twelfth thoracic vertebrae), involve the pathways of inhibitory impulses from the higher centers. Injuries which occur at the conus or below, in the cauda equina, do not interfere with these inhibitory tracts but damage only the reflex arc.

Perhaps of more importance than the level of the lesion is whether it is complete or incomplete. The sparing of nerve tracts and late recovery of the ability to transmit impulses account for unpredictable improvement in many cases.

In the great majority of cases two types of neurogenic vesical dysfunction were demonstrable. There was either an automatic or a reflex type of bladder, in which the lesion was, as a rule, above the tenth thoracic vertebra, or a retention bladder with overflow incontinence, in which the injury was usually below the tenth thoracic vertebra and generally involved the cauda equina.

The type of dysfunction which is caused by lesions low in the spinal column that usually involve the cauda equina is the most responsive to transurethral resection. Examination through the cystoscope shows various degrees of relaxation of the neck of the bladder. In some cases the region of the internal urethral orifice is constricted so that the bladder and dilated prostatic urethra have an hourglass appearance. In some cases, a bar type of deformity and in others an appearance like that of the vocal cords are seen. In all cases the vesical wall is trabeculated.

In cases of cord bladder, enough tissue is removed from the entire circumference of the vesical neck to make a definite funnel of the prostatic urethra. Postoperative retention depends, as after prostatectomy, on the external sphincter. To make this funnel requires the removal of but a small amount of tissue. If the first resection does not produce the desired effect, multiple operations are indicated, although the total amount of tissue excised seldom exceeds 10 Gm. In 16 cases of this series multiple resections were employed. Of 39 patients whose injury was at or below the level of the eleventh thoracic vertebra and for whom transurethral resection was performed, 36 could urinate voluntarily when the report was made. Each could empty his bladder completely by straining, could sleep through the night without voiding and was continent. Each could tell when his bladder was full, although the sensation which he described is not normal—a dull ache or heavy feeling in the lower part of the abdomen.

Transurethral resection has been of much, though less, benefit in cases of lesions high in the spinal column in which automatic or reflex dysfunction has been established but function is inefficient in that the bladder does not empty completely. Thus reflex stimulation might occur when the bladder contains 400 cc. of urine and voiding takes place. If, however, 200 cc. of residual urine remains after voiding, one must class this as an inefficient type of automatic bladder. The patient is deprived of the full reservoir function of the bladder. If, in some way, the bladder can be made to empty completely, the interval of time between reflex urinations can be doubled. In 19 of these cases transurethral resection diminished or entirely abolished the amount of residual urine, and in almost all cases in which previously it had been impossible to free the urine of infection the urine became crystal clear and finally free of pathogenic organisms. Resection in such cases did not produce incontinence. To the contrary, it tended to relieve it.

Until such time as the bladder has recovered whatever emptying and retaining function it is going to regain after the initial injury, the question of drainage is paramount. In the first few weeks following injury the use of a urethral catheter, if it can be properly maintained, is the easiest method of caring for vesical drainage. In cases in which drainage will be necessary late into convalescence, suprapubic drainage is preferable. To increase the capacity of the bladder and to try to overcome its spasticity, tidal drainage is used early in convalescence.

A total of 58 patients were treated by transurethral resection; in 57 cases the operation was successful, but in 1 case the result was total failure. Only 6 patients are now dependent on catheters; 93 can pass urine without mechanical assistance of any kind. Of this number, 53 have a voluntary type of urination, while in 40 it is automatic.

Emmett and Dunn [27] discuss transurethral resection in the surgical management of cord bladder. Cord bladders are characterized by (1) increased tone of the bladder with trabeculation, (2) presence of residual urine and (3) "active" incontinence. Inefficient vesical contractions result in intermittent urination which varies from frequent spurts of small amounts to sudden precipitate evacuations at reasonably long intervals of larger volumes of urine. The inefficient vesical contractions are unable to overcome the obstruction completely because of the spasticity of the vesical neck, and residual urine is the result. Removal of this obstruction of the vesical neck should therefore tend to eliminate the residual urine.

One characteristic type of cystoscopic appearance of the true cord bladder is the more or less constant "writhing" appearance of the bladder, which appears to be constantly undergoing irregular contractile

27. Emmett, J. L., and Dunn, J. H.: Transurethral Resection in the Surgical Management of Cord Bladder, Surg., Gynec. & Obst. **83**:597-612 (Nov.) 1946.

efforts which may make satisfactory distention with water through the cystoscope rather difficult.

If the vesical neck is kept under observation during these contractile efforts of the bladder, it will be noticed that the vesical neck also goes through more or less the same type of contraction and dilatation. When the condition has been of relatively long standing the vesical neck may appear to be thick and hypertrophic. If considerable infection has occurred, fibrosis and fixation also may be associated. In some cases the vesical neck appears to have a "collar" of tissue surrounding it, so that it has much the same appearance as a collar of adenomatous tissue. Among older patients, in addition, varying degrees of prostatic hyperplasia may be present. Massive hypertrophy of the interureteric bar also is a common observation.

In some cases, spasticity and hypertrophy of the bladder may be of only minimal degree, and it may be difficult to demonstrate a contracture or collar at the vesical neck. Thompson has suggested that in these cases, if the bladder be well distended with water, a prominent contraction ring at the vesical neck will become apparent. If a contraction, spasticity or collar obstruction at the vesical neck is not demonstrable to the satisfaction of the cystoscopist, it is unimportant so far as diagnosis and treatment are concerned. Resection of the vesical neck will yield good results in spite of the cystoscopic appearance of the structures, and often the obstruction will become apparent only after resection has been started.

The object of the procedure is to remove as completely as possible the hypertrophic or spastic vesical neck (formerly called "internal sphincter") and any hypertrophied or normal prostatic tissue that may also be present. The difficulty in such a procedure is determination of when resection has been carried deeply enough at the vesical neck to remove its contractile ability, and yet to avoid perforation of the bladder at this point. A number of operations will require a second or even third resection to secure satisfactory results. If the surgeon tries to achieve sufficiently complete removal of tissue at the first operation in every case, he will occasionally encounter bleeding from the edge of the bladder and from the prostatic capsule. Such bleeding is difficult to control and even when controlled will tend to recur at intervals, for several days or weeks.

For reasons not too easily explained, it is often possible to resect a vesical neck much more widely at a second operation than at the first. A "shift" of the tissues in the area of operation seems to occur, so that the second time as much tissue can be removed as at the first operation, and it may be possible to remove more. Owing to disturbance of the blood supply, the tissue is more or less avascular, and lines of demarcation are more easily recognized than at the first operation. At a second resection the operation may be carried safely to a depth which would have involved great risk at the first operation.

The interureteric bar at times is enlarged to a tremendous degree, and is definitely obstructive. Cautious removal of this bar and some of the hypertrophic vesical wall near the vesical neck (often in the anterior quadrant) may be necessary.

The writers report the results with transurethral resection in 30 cases of cord bladder as follows: good, 23 cases; improved, 4 cases; fair, 2 cases; poor, 1 case. They conclude that cord bladder is no longer a hopeless situation and that satisfactory vesical function can be restored by mechanical adjustment of the vesical neck through transurethral resection and by teaching the patient to use unaffected muscles to aid him to void.

Miscellaneous.—Frost [28] discusses urinary incontinence in the female and states that while it may be a separate entity it is most commonly associated with urethrocele or cystocele and also, at times, a downward rotation of the urethra under the symphysis. In many cases there is relaxation of the vesical sphincter resulting in a combined cystourethrocele and a shortening of the urethra. Not all of these patients are incontinent, however, and Frost therefore believes that there are added factors including damage to the voluntary muscles of the urethra. The mere tightening of the neck of the bladder by plication and failure to correct the damaged urethral muscle may be the explanation of operative failures. Frost presents the following fundamentals for the surgical procedure in the correction of incontinence: (*a*) free mobilization of the bladder by its separation from the anterior vaginal wall, posteriorly from the cervix as far as the uterovesical fold, laterally until the vesicovaginal fascia is visualized as a smooth capsule and upward laterally under the pubic rami on each side to free the urethra, and (*b*) plication of the urethra and base of the bladder without tension from a point just below and lateral to the external urinary meatus and continued posteriorly to a point which includes the vesical sphincter. Thus the urethra is lengthened and the damaged voluntary muscle and relaxed sphincter are repaired. Added support to the urethra and bladder is created by means of strips of tissue excised from the anterior vaginal wall and sutured to the under surface of the symphysis and the vesical neck. The desired result is the restoration of the urethra, vesical sphincter and base of the bladder to their normal anatomic relationships.

PROSTATE

Neoplasms.—McCrea [29] states that there is no uniformity of opinion as to the best form or dosage of estrogens to be used in the treatment

28. Frost, I. F.: Urinary Incontinence with Special Reference to Certain Factors Which Are Necessary in the Cure of This Condition, Am. J. Surg. **71**:172-179 (Feb.) 1946.

29. McCrea, L. E.: Carcinoma of the Prostate: A Résumé of Treatment with Ethinyl Estradiol; Preliminary Report, J. Urol. **56**:697-703 (Dec.) 1946.

of carcinoma of the prostate. The estrogen usually employed is diethylstilbestrol. McCrea discusses the use of ethinyl estradiol in the combined treatment (orchiectomy and estrogen) of this condition.

Harding states that ethinyl estradiol is "the most potent oral estrogen used up to the present time." Kearns considers that ethinyl estradiol has a potency six times greater than diethlystilbestrol.

A survey of cases in which the recently advocated combined therapy was not used reveals interesting statistical data. Consideration of these data will permit a closer parallel to be drawn with the modern concepts of treatment. An analysis of 812 cases of prostatic carcinoma at the Philadelphia General Hospital and Temple University Hospital is used as a basis for the statistical data. The average age of patients was found to be 66.94 years at the time of hospital admission. It often has been stated that prostatic carcinoma occurs most frequently between the ages of 50 and 60 years. In a recent analysis of 581 cases of prostatic hypertrophy McCrea found the average age of the patients to be 63.2 years. These data tend to prove that prostatic carcinoma occurs most frequently in the same age bracket as does prostatic hypertrophy but at a slightly higher level.

Of patients who had prostatic carcinoma 647 were white men and 165 were Negroes: a ratio of 4 to 1. In a recent survey of 581 cases of prostatic hypertrophy a ratio of 10 to 1 was found. If such an analysis of a total of 1,393 cases of prostatic enlargement is considered as an indication of the relative frequency of occurrence of this type of prostatic disease, it then is obvious that prostatic disease occurs seven times more frequently among white men than among Negroes. In this series of 812 cases, metastasis was proved to have occurred in 345, or 42.5 per cent. Metastasis was not demonstrated in 244 instances. The average time of survival following admission to the hospital was thirty-six and two-tenths weeks, in 729 cases. According to the records of the patients, the duration of symptoms varied from one week to ten years before the patients were admitted to the hospital.

The usually observed symptoms were frequency of urination, difficulty of urination, nocturia, urinary retention, hematuria and incontinence of urine.

In a series of 15 patients who underwent orchiectomy and were given estrogenic therapy, ethinyl estradiol was used instead of diethylstilbestrol. The dosage schedule routinely employed was a thirty day period in which 0.05 mg. of ethinyl estradiol was given once a day, alternating with a thirty day rest period. One patient has now been on such a regimen for twenty-seven months. The results routinely attained were good and compared more than favorably with the results attained with diethylstilbestrol.

The decrease in size of the prostate is remarkable in most instances following institution of the combined use of orchiectomy and estrogens. In this series of 15 cases, it has not been necessary to perform a single transurethral resection after the institution of combined therapy. When originlly examined many of McCrea's patients had acute urinary retention. Drainage with an indwelling catheter was instituted. Within a month after orchiectomy without exception it was possible to remove the catheter, obviating the necessity of transurethral resection. Undoubtedly if this series were larger there would have been instances in which decrease would not have occurred and transurethral resection would have been necessary. It is further believed that certain types of prostatic carcinoma exist which respond differently to estrogenic therapy.

The breasts may become grossly enlarged and are sometimes painful. Such reactions are the exception rather than the rule. Kearns in a report on the use of the drug states that similar beneficial and untoward effects as well have occurred with ethinyl estradiol with the exception that there is definitely less stimulation of the breasts with the true hormone and possibly less gastric irritation. Not only is the tenderness of the breasts less likely to develop with estradiol but changing from stilbestrol to estradiol brings about diminution of the tenderness.

Edema of the lower extremities may be seen occasionally during estrogen therapy. The edema may be unilateral or bilateral and is usually not of great clinical importance.

Chase, Burt and Hess [30] report their use of orchiectomy in the treatment of carcinoma of the prostate in 54 cases. They state that inhibition of androgens by administration of estrogen is unsound because it is incomplete and that bilateral orchiectomy is the method of choice as basic treatment in prostatic carcinoma because it removes all of the androgens. The only exception would be in those cases seen early enough to do a complete perineal prostatectomy. Of their 54 patients, 46 were still alive, 4 were dead of irrelevant causes, 25 were fully employed and 6 received no benefit.

Nesbit and Plumb [31] report on 795 cases of prostatic carcinoma diagnosed and treated at the University of Michigan Hospital between 1925 and 1940.

Comparative data at the present time indicate that survival rates are significantly increased by endocrine modifications in the series studied.

30. Chase, D. W.; Burt, K. L., and Hess, E.: Orchiectomy in the Treatment of Carcinoma of the Prostate, Am. J. Surg. **71**:522-525 (April) 1946.

31. Nesbit, R. M., and Plumb, R. T.: Prostatic Carcinoma: A Follow-Up on Seven Hundred and Ninety-Five Patients Treated Prior to the Endocrine Era and a Comparison of Survival Rates Between These and Patients Treated by Endocrine Therapy, Surgery **20**:263-272 (Aug.) 1946.

Whether other or comparable series would show a similar advantage in favor of endocrine therapy can only be the subject for speculation, but the comparative survival rates among cases in which metastasis had occurred suggests that castration or estrogenic therapy has a beneficial influence on the survival curve.

Ormond [32] discusses radical perineal prostatectomy for carcinoma of the prostate. He states that the criteria for selection of patients suitable for this operation are important. First and foremost, there must be no evidence of metastasis or extension. The prostate must not be fixed to the pelvic wall and there must be no induration at the apex of the prostate involving the membranous urethra. Some extension to the lower part of the seminal vesicle is not a contraindication. In most of the cases only a suspiciously hard nodule was present in one lobe. In a few the whole gland was hard when felt through the rectum. Roentgenograms did not reveal evidence of metastasis in any case and in all cases encountered recently the acid phosphatase of the blood was normal.

In view of the hopeless prognosis otherwise, the low operative mortality rate of the operation, the rarity of postoperative incontinence and rectovesical fistula and the fact that apparently the operation at least does not hasten metastasis even when it does not cure and does prevent recurrence of obstruction, Ormond believes the operation is useful and that it should be used more widely. A corollary to this is that members of the medical profession should be educated to recognize the condition early and that men past 50 years of age should have the benefit of a careful rectal examination every year.

Miscellaneous.—Berry and Miller [33] discuss regeneration of epithelium of prostatic urethra following resection. They examined patients after various intervals postoperatively and took sections for microscopic examination. These sections were obtained from a few days to three years after operation.

For the first two weeks after operation the prostatic cavity is covered with superficial slough and adherent mucus with a red surface showing through here and there. After from two to three weeks the slough has separated except where large tags of devitalized tissue are left and the prostatic cavity is clean, red and glistening except at the vesical neck, especially on the floor just below the trigone. Slough is still present at this point in many cases. Not infrequently after three weeks definite islets of epithelium can be seen in the prostatic cavity. At the end of a month the entire area should be completely healed.

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32. Ormond, J. K.: Radical Perineal Prostatectomy for Carcinoma of Prostate, Surgery **20**:257-262 (Aug.) 1946.

33. Berry, N. E., and Miller, J.: Regeneration of Epithelium of Prostatic Urethra Following Resection, J. Urol. **56**:223-227 (Aug.) 1946.

Microscopically, there is first superficial necrosis and sloughing with infiltration of inflammatory cells followed by the development of granulation tissue. During this period there is proliferation of the epithelium in the ducts and acini near the surface and metaplasia to the transitional type, the acini at times becoming completely filled. About three weeks after resection, epithelium can be seen spreading out onto the surface of the new granulation tissue. This takes place from a large number of points, and consequently epithelization is completed rapidly, usually within a month.

The postoperative course in these cases follows closely what one would expect from a study such as this; that is, frequency, pyuria and irritation are present during the period when slough is separating and there is an inflammatory process on the surface. Either separation of slough or trauma to the delicate new granulation tissue would account for bleeding. After three weeks, when the new epithelium begins to cover over, all these symptoms begin to subside. Ordinarily after a month healing is complete and the patient would be expected to be free of discomfort. It is only then that one would expect the pyuria to begin to clear up, and it usually does. This process of healing progresses with marked regularity, though infection and encrustation may delay its completion.

URETHRA

Traumatic Injuries.—MacLean and Gerrie [34] present a method for the repair of wounds of the perineal portion of the urethra in which split thickness skin grafts are used. The results in 2 cases are described.

Skin cut from the bicipital region of the left arm with the Padgett dermatome at a calibrated depth of 0.015 inch (0.0381 cm.) was used to build a tube around an inflated intratracheal cuff drawn over a two way Foley bag catheter. By inflating the cuff slightly, it was possible to build this portion of the urethra to a much larger caliber than normal, thus allowing in advance for shrinkage as healing and the surrounding fibrosis became complete. Multiple holes were also cut in the intraurethral portion of the catheter so that irrigation of the anterior portion of the urethra could be carried out, if desired, without disturbing the graft. The features of a skin graft considered to be desirable are: (1) hairless skin with as few glandular or accessory skin structures as possible; (2) soft, pliable skin; (3) skin with a limited amount of elasticity to minimize the constricting action on the urethral channel, and (4) a thin graft to enhance the probability of take. By using a perineal exposure the tube graft can be placed in the exact position desired. The urinary stream was diverted by suprapubic cystostomy.

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34. MacLean, T. T., and Gerrie, J. W.: Repair of War Wounds of the Bulbous and Membranous Urethra Using Split Thickness Skin Grafts and Penicillin, J. Urol. **56**:485-497 (Oct.) 1946.

The use of penicillin for twenty-four hours preoperatively and fourteen days postoperatively materially influenced the results. Primary healing occurred in both cases. The urethra must be kept distended with a catheter for at least ten weeks after the operation, then dilated at weekly intervals, the period of time between dilations being gradually prolonged until the patency of the urethra is maintained.

Diverticulum.—Zide and Siegel [35] report a case of acquired diverticulum of the anterior part of the urethra. The patient was a 31 year old white man who complained of painful urination, decreased force of the urinary stream, dribbling of urine after voiding and perineal swelling. Fourteen months previously the patient had fallen on a rock striking the perineum. Examination revealed a cystic swelling of the midperineum 1 to 2 cm. in diameter which appeared after voiding. Pressure on the mass caused urine to flow from the urethra. A urethrogram revealed a stricture in the proximal third of the anterior portion of the urethra with a diverticulum 1 cm. in diameter arising from the floor of the urethra at the proximal end of the stricture. The stricture was dilated and urethral diverticulectomy was performed. Eight days postoperatively the indwelling urethral catheter was removed and the patient voided freely without dribbling. The writers state that the condition is rare and usually is due to a combination of urethral obstruction plus local trauma, as was demonstrated in this case.

PENIS

Congenital Anomalies.—Goldstein [36] reports 3 cases of penoscrotal hypospadias in which a modified Ombrédanne operation was employed, with satisfactory functional results. Goldstein states that the operation is simple, safe and sound, and can be performed on children or adults. The chance for infection is tremendously reduced. It avoids the necessity of urinary diversion and even introduction of a catheter. If other operative procedures have failed, the Ombrédanne technic should be used. Gentleness is of extreme importance.

Stirling [37] reports a case of true bisexuality verified by positive biopsy findings. Bilateral cryptorchidism was found. The external genitals were gynecoid, the urethra was in the perineum and the external vaginal orifice was absent. Examination of the abdominal contents disclosed an infantile uterus, a tube and ovary on the right side. A well formed

35. Zide, H. A., and Siegel, M. S.: Diverticulum of the Anterior Urethra: Report of an Acquired Type, California Med. **65**:279-281 (Dec.) 1946.

36. Goldstein, A. E.: Modified Ombredanne Operation for the Repair of Penile Hypospadias, J. Urol. **56**:746-756 (Dec.) 1946.

37. Stirling, W. C.: Report of a Case of True Hermaphroditism: A Discussion of the Thirty-Seven Cases Previously Reported, J. Urol. **56**:720-724 (Dec.) 1946.

testicle and cord were later found on the left side. The phallus was well formed, devoid of urethra and did not represent an enlarged clitoris. Androgen and estrogen assays revealed a preponderance of female hormones.

Injections of testosterone propionate were utilized and produced marked secondary sex changes.

De Moura and Basto [38] present a case of true hermaphroditism in which the patient had a normal penis, with a testicle, epididymis, seminal vesicle and prostate and was able to secrete sperms. Besides, the patient had a uterus, functionally active ovary and monthly bleedings through the urethra. This is probably the first case in which the presence of a normal ovary and a normal testicle with presence of both ovules and sperms has been observed.

Inflammatory Conditions.—Lewis [39] states that tuberculosis of the penis is a rare disease. In the literature 110 cases have been reported. In 72 the condition resulted from ritual circumcision, leaving 38 cases in which the condition resulted from other causes.

The disease may be primary or secondary, primary when no other endogenous focus can be demonstrated or secondary to foci either in the lung or genitourinary tract or both. Treatment has been rather unsatisfactory and the prognosis unfavorable. Five cases are reported from the Brady Urological Institute. In 3 the condition was primary, and in 2, secondary.

A hypothesis as to the mode of infection in so-called secondary infection is reiterated. According to this hypothesis secondary infection in most cases results from reinoculation through coitus.

Neoplasms.—Lenowitz and Graham [40] state that, in general, carcinoma of the penis is of low grade malignancy. If it is diagnosed early and proper surgical treatment or irradiation is instituted, the results would compare favorably with those obtained in treating carcinoma of the exposed skin surfaces of the body. It is also a slowly growing tumor, and many years may elapse before the discomfort caused by the tumor causes the patient to seek medical aid.

Carcinoma of the penis may be mistaken for a chancre, chancroid, tuberculosis, balanitis, herpes progenitalis, gummatous ulceration or granuloma inguinale. A biopsy of all penile tumors should be performed to avoid error in diagnosis.

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38. de Moura, A. C., and Basto, L. P.: True Hermaphroditism, J. Urol. **56**: 725-730 (Dec.) 1946.

39. Lewis, E. L.: Tuberculosis of the Penis: A Report of Five New Cases, and a Complete Review of the Literature, J. Urol. **56**:737-745 (Dec.) 1946.

40. Lenowitz, H., and Graham, A. P.: Carcinoma of the Penis, J. Urol. **56**: 458-484 (Oct.) 1946.

Prolonged irritation is agreed on by most writers as the most important single cause of carcinoma of the penis. In penile cancers the prepuce is almost always tight or long and may be adherent to the underlying glans. There is retention of smegma with continuous irritation. Carcinoma of the penis, as well as carcinoma elsewhere on the body, usually develops during the cancer age, from 40 to 70 years. However, it may occur in the earlier and later stages of life.

Two types of carcinoma were observed by the writers, papillary and infiltrating. The papillary type was either ulcerative or nonulcerative. The papillary type was the more frequent. Either type may arise from the mucous membrane of the penis. Occasionally, carcinoma may develop on the skin of the shaft of the penis distal to the corona.

Histologically, carcinoma of the penis is similar to squamous cell carcinoma found elsewhere on the surface of the skin. Spread of the tumor is by way of the penile lymphatics which, with those of the scrotum, lower part of the abdomen and thighs, are part of one system draining into the inguinal and femoral lymph nodes. Metastasis probably takes place by embolism or by the migration of a group of malignant cells via the lymphatic channels, terminating in the lymph nodes. Metastasis to distant organs is infrequent and probably occurs as an embolic phenomenon by way of the blood stream.

There are three principal intercommunicating lymphatic systems. The first forms an abundant superficial set in the skin and subcutaneous tissue, its afferents draining into the superficial inguinal lymph nodes. These in turn anastomose with the deep inguinal nodes. The second system drains the glans penis and enters the deep inguinal nodes, which in turn anastomose with the external iliac nodes of the pelvis. Of the third system of lymphatics, those of the corpus spongiosum urethrae empty into the deep inguinal nodes with the lymphatics of the glans, while others end in the nodes along the external iliac vessels following the course of the dorsal vein of the penis. Involvement of inguinal nodes apparently depends primarily on the degree of malignancy of the primary lesion and not on the duration or the extent of involvement of the penis by the carcinoma. Early involvement of the inguinal nodes may take place in a highly malignant neoplasm shortly after the onset of the primary lesion. On the other hand, in cases in which a penile lesion has been present for a long time evidence of metastasis may not be found.

There are no symptoms pathognomonic of carcinoma of the penis. Pain early or late in the disease may cause the patient to seek relief. A discharge from beneath the prepuce may attract attention, but may be frequently disregarded, especially when the patient previously has had gonorrhea. Bleeding may occur in some cases and cause some alarm. Urinary obstruction may send the patient to the physician. In other

cases increasing phimosis with marked discomfort leads the patient to believe that circumcision is necessary for relief.

Carcinoma of the penis is treated by roentgen therapy or surgical means or a combination of these methods. A lesion 2 cm. or less which does not involve Buck's fascia is treated entirely by irradiation. The response to irradiation should be as good as that obtained in treating cancer of the skin of similar extent of involvement. Roentgen therapy is used (1) as the sole method of treatment in an attempt to cure the patient, (2) as preoperative irradiation preliminary to surgical intervention and (3) as palliative treatment.

Larger lesions involving Buck's fascia or the cavernous bodies are at the present time best treated by roentgen therapy and operation. Simple amputation is advisable whenever part of the organ can be saved. As in surgical treatment of tumors elsewhere in the body, wide excision of the neoplasm must be the aim to prevent recurrence. When the lesion is too extensive and part of the organ cannot be saved, total extirpation of the penis is the operation of choice. Metastatic or suspicious nodes should be treated by irradiation after block dissection. It is best to treat unilateral involvement of the groins as though bilateral involvement were present in order to prevent recurrence. Emasculating operations are indicated only when the scrotum is invaded by the neoplastic growth.

Lenowitz and Graham performed major operations on 82 patients who had carcinoma of the penis and present a thorough discussion of several surgical procedures used.

TESTES

Traumatic Injuries.—Ockuly [41] reports a case of traumatic dislocation of the testis. The patient was a 24 year old soldier. Ockuly states that to date only 71 cases of true dislocation have been reported in the literature, and defines the condition as the displacement of a previously normally located testis to a nonscrotal position by being forcibly propelled through normal anatomic apertures or along fascial planes, the integument of the body remaining intact. Displacement may be to the superficial fascia of the lower part of the abdomen, dorsum of the penis, perineum, crural area of the thigh, inguinal canal, femoral canal or abdominal cavity. If nonsurgical replacement is impossible, early surgical treatment is indicated.

Inflammatory Conditions.—Nixon and Lewis [42] discuss orchitis due to mumps and its surgical treatment. Orchitis usually occurs before the

41. Ockuly, E. A.: Traumatic Luxation of the Testis, Am. J. Surg. **71**:93-95 (Jan.) 1946.

42. Nixon, N., and Lewis, D. B.: Mumps Orchitis: Surgical Treatment, J. Urol. **56**:554-560 (Nov.) 1946.

complete subsidence of the parotitis. In rare instances it may precede the parotitis by a number of days and in other cases may be the only manifestation of mumps. Occasionally orchitis will occur three to six weeks after the onset of parotid swelling.

The patient's temperature curve is helpful in diagnosis, both in the early stage and in the subsequent course of testicular involvement. The temperature usually rises shortly before the patient begins to complain of testicular tenderness. As swelling occurs, the temperature goes higher, sometimes to 105 F., and the patient complains of chilliness, backache, malaise, nausea and vomiting. The testis becomes hard, smooth and exquisitely tender and remains so for at least four or five days. The temperature then drops by lysis, and swelling subsides. The usual duration of the orchitis is about ten days. In some cases, especially those in which orchitis develops more than fourteen days after the onset of parotitis, general symptoms are few. The pathologic picture is one of accumulation of hydrocele fluid between the tunica vaginalis and the tunica albuginea which may result in pressure necrosis of the seminiferous tubules, with subsequent partial atrophy of the testes.

Nixon and Lewis used the following surgical procedure for treatment in 66 cases of orchitis due to mumps: After infiltration of a 2 per cent solution of procaine hydrochloride, a small incision, approximately 2 cm. long, is made over the anterior surface of the scrotum on the involved side. The incision is carried through the skin and subcutaneous tissues until the tunica vaginalis is exposed. This is grasped with two Allis clamps and incised. Usually the hydrocele fluid drains out under considerable pressure. A small Penrose drain is inserted beneath the tunica vaginalis and the wound is closed. After operation most patients reported immediate alleviation of extreme pain and discomfort. Others showed improvement within two to four hours, with relief not only from pain but from headache, nausea and vomiting as well. Within twenty-four hours the local swelling was considerably reduced and the testis could be palpated with little discomfort to the patient. Drainage was maintained for at least twenty-four hours.

Neoplasms.—Goodwin [43] discusses multiple benign fibrous tumors of the tunica vaginalis. Examination reveals a scrotal mass which is extratesticular and extends upward from the upper pole of the epididymis and may seem to originate in the cord or the epididymis. The tumor is multinodular and fibrous, nearly stony hard, yet apparently freely movable. It may suggest a calcified varicocele, and roentgenologic examination may sometimes reveal small areas of calcification within the mass. In the event of much thickening of the tunica vaginalis or associated

43. Goodwin, W. E.: Multiple, Benign, Fibrous Tumors of Tunica Vaginalis Testis, J. Urol. **56**:438-447 (Oct.) 1946.

hydrocele the mass may seem to be a part of the testis or epididymis and may then definitely suggest a malignant lesion of the testis. The correct preoperative diagnosis is made only about half of the time; this is probably due as much as anything to the rarity of the condition.

Operation is indicated as it is in the case of any intrascrotal mass in which malignancy must be ruled out. Careful inspection of the tumor at operation, however, is mandatory, for there is a good chance that an extratesticular tumor is benign, and unnecessary orchiectomy is unfortunate indeed. Simple excision of the tumor and possibly the epididymis, with which it often lies in close contact, is indicated if the mass is obviously benign. If there is any question, biopsy and, if necessary, orchiectomy should be carried out.

Grossly the tumor has a typical fibroid appearance and is covered with a smooth, glistening membrane, probably the tunica vaginalis. It looks like typical multiple fibromas elsewhere in the body. Microscopically one sees whorls of fibrous tissue and a few typical spheroids. There is thickening of the vessel walls, and some portions present hyalinization and even calcification. There are frequent scattered areas of focal lymphocytic infiltration and some plasma cells indicating chronic inflammation.

Goodwin suggests that the term "chronic proliferative periorchitis" be reserved for simple chronic inflammatory thickening of the testicular tunics, and that multiple fibrous nodules which appear separate from the testes, and apparently originate in the tunica vaginalis, retain the clinically more acceptable term of "multiple fibromata" even though they may show marked inflammatory changes and may represent the same disease process as "chronic proliferative periorchitis."

Goodwin and Vermooten [44] present 2 cases of multiple fibromas of the tunica vaginalis. It is felt that these tumors may really represent a proliferative type of chronic periorchitis. The clinical diagnosis in these cases, because of the rarity of the condition, is seldom correct preoperatively, in spite of the fact that the physical findings are so definite and characteristic that once having seen such a nodular tumor, one would not be likely to err a second time. In reports of several of these cases which the writers have collected, the testis was removed needlessly because the benign nature of the tumor and its origin were not recognized at or before operation. It certainly behooves the surgeon to make careful preoperative examination and in cases of doubt to await the microscopic examination of a biopsy specimen, taken at the time of operation, before performing orchiectomy. The treatment is and always must be surgical, even in known tumors of the tunica vaginalis.

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44. Goodwin, W. E., and Vermooten, V.: Multiple Fibromata of Tunica Vaginalis Testis or a Proliferative Type of Chronic Periorchitis: A Report of Two Cases, J. Urol. **56**:430-437 (Oct.) 1946.

Nesbit and Lynn [45] studied 80 cases of malignant tumors of the testis and found that the survival rate in the entire group was 23.8 per cent. In 33.3 per cent of 51 cases in which metastasis was not demonstrable the patients were alive after an average of eleven years. They found that an occasional cancer of the testis which had metastasized can apparently be cured by orchiectomy and roentgen therapy. The average age in the group of cases reviewed was 35.7 years and the average duration of symptoms was twenty and five-tenths months. Occasionally testicular neoplasms exhibit an acute onset resembling epididymitis or acute hydrocele. They found only 33.5 per cent of 54 cases displayed significantly elevated gonadotropic levels. The titer of gonadotropin should be at least 500 mouse units before the test is considered significant. A negative result of the test for gonadotropin means nothing; however, a positive response dictates a grave prognosis. In certain cases in which metastasis occurs following treatment results of the hormone test may be positive when they had been negative before therapy. Once adequately treated, the patient will either survive or perish, and no further endeavor on the part of the physician will alter the outcome significantly except in rare instances. Metastatic lesions which fail to regress or which become clinically evident following initial irradiation will not respond favorably to additional high voltage.

In a study of 922 tumors of the testis, Friedman and Moore [46] classified 96 per cent of such new growths as seminoma, embryonal carcinoma, teratoma or teratocarcinoma.

Seminomas and embryonal carcinomas are distinct tumors which differ not only in fundamental cell type but in biologic behavior and prognosis. Chorioepitheliomas are considered a subvariety of embryonal carcinomas. The term "teratocarcinoma" is applied to those tumors which show both differentiated teratoid structures and malignant elements and are thought to result from teratoid differentiation in embryonal carcinomas. Monocellular testicular neoplasms ordinarily do not originate from preexisting teratomas.

Virtually all embryonal carcinomas metastasize as monocellular embryonal carcinomas, but choriomatous characteristics may be evident in the metastatic lesions of embryonal carcinomas or teratocarcinomas even when they are not manifest in the primary tumor. Roughly half of the teratoid neoplasms which metastasize give rise to growths with teratocarcinomatous structures and half to pure embryonal carcinomas.

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45. Nesbit, R. M., and Lynn, J. M.: Malignant Testicular Neoplasms: Analysis of Eighty Cases, Surgery **20**:273-279 (Aug.) 1946.

46. Friedman, N. B., and Moore, R. A.: Tumors of the Testis: A Report on Nine Hundred and Twenty-Two Cases, Mil. Surgeon **99**:573-593 (Nov.) 1946.

Immediate prognosis is bad in cases of embryonal carcinoma and chorioepithelioma and poor in cases of teratocarcinoma and adult teratoma, which should be regarded as matured teratocarcinomas. In cases of seminoma, in comparison with the other testicular tumors, the immediate prognosis is good.

The architecture of testicular tissue is not reproduced in seminomas, and the neoplastic cells do not resemble spermatogonia. Seminomas are probably tumors of primordial germ cells and should be called germinomas. Embryonal carcinomas and teratoid tumors, which are composed of evolving and differentiating somatic and trophoblastic tissues, are neoplastic expressions of the unlimited potencies of embryonic cells.

Miscellaneous.—Huhner [47] outlines a procedure for aspiration of the testis for spermatozoa. A few drops of tincture of iodine is applied to the skin at the proposed site of puncture, and a long needle attached to an ordinary hypodermic syringe is plunged through the entire body of the testis and epididymis, and suction is applied as the needle is withdrawn slowly. A small amount of collodion is applied after the needle is withdrawn. No anesthetic is used, and the patient may resume his ordinary work within a half hour after the procedure.

In the examination of the aspirated fluid, two precautions must be observed. In the first place it is important to put the point of the needle directly on the slide and express the fluid. If air is first expelled from the needle, as is the custom in ordinary hypodermic methods, all or most of the spermatozoa may be lost, for they seem to stick to the very point of the needle, and the second precaution is to look for a long while, sometimes as long as an hour or until all the aspirated fluid has been examined.

This method is purely for diagnosis, to answer the question of whether the testis makes spermatozoa or does not or, in other words, to determine whether epididymovasostomy is worth trying.

Huhner believes that aspiration is superior to biopsy because with the latter conclusions are drawn from the examination of only a small portion of one or both testes, and biopsy of various portions of the same testis yields different results.

EPIDIDYMIS

Neoplasm.—Codnere and Flynn [48] report 3 cases of adenomatoid tumors of the epididymis.

Adenomatoid tumors of the epididymis are globular or oval in shape, less than 2 to 3 cm. in diameter, sharply circumscribed and encapsulated.

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47. Huhner, M.: The Investigation of the Spermatogenic Function of the Testicles in Cases of Azoospermia, J. Urol. **56**:266-268 (Aug.) 1946.

48. Codnere, J. T., and Flynn, J. E.: Adenomatoid Tumors of the Epididymis: Report of Three Cases, J. Urol. **56**:448-453 (Oct.) 1946.

The cut surface is firm and white to gray. Microscopically, these tumors consist of a fibrillar stroma in which are embedded tubular-like structures lined by cuboidal to flattened cells having prominent dark-staining or vesicular nuclei and acidophilic cytoplasm.

On the basis of histologic similarity, aberrant mesonephrogenic structures are thought to constitute the genetic foundation of these neoplasms.

Bothe, Cristol and Devers [49] state that tumors of the epididymis, while more rare than solid tumors of the testes, are less frequently malignant. Two cases of epididymal tumors are presented in which accurate diagnosis was not made until after an exploratory operation and cytologic study.

Benign tumors are found to constitute approximately 30 to 40 per cent of all tumors of the epididymis. The myoma appears to be the most frequently found variety of this rare group of benign growths.

As with testicular neoplasms, tumors of the epididymis rarely cause symptoms. Their presence is detected when trauma directs the attention of the patient to the scrotum or when the physician carefully examines the scrotal contents. Since many of these tumors cannot be definitely separated from the testes on physical examination, the treatment of epididymal masses resembles the treatment for testicular masses. Any patient who has an intrascrotal solid mass deserves surgical exploration. The subsequent treatment will depend on the location and the nature of the mass found. In the case of benign epididymal lesions, removal of the mass together with the associated epididymis will suffice.

GENERAL

Melick [50] discusses the advantages of cotton as a suture material in urologic operations, including scrotal, ureteral and renal operations. He states that uniformly excellent results have been obtained without formation of a chronically draining sinus. No. 80 cotton is used for the ligation of all ordinary bleeders, while for large vessels either catgut or a larger gage of cotton suture was used. No. 80 cotton is also used to close all layers of scrotal incisions. No. 30 or 40 cotton is used in approximating muscle and fascial layers. Multiple fine interrupted sutures are used, the stitches being placed about 0.5 cm. apart and only small amounts of tissue being included in each stitch. Correct technic is practically forced on the surgeon with these sizes of cotton, since if too much tissue is included in each bite the suture will break when an attempt is made to tie it. Renal incisions are closed by

49. Bothe, A. E.; Cristol, D. S., and Devers, P. J.: Benign Tumors of the Epididymis, J. Urol. **56**:710-714 (Dec.) 1946.

50. Melick, W. F.: The Advantages of Cotton as a Suture Material in Urological Surgery, J. Urol. **56**:602-608 (Nov.) 1946.

suturing the posterior, middle and anterior layers of the lumbodorsalis fascia separately, and the muscles are not sutured. In closure of a ureterotomy incision, the muscles are approximated loosely and then the external fascia is closed. The skin is approximated with either vertical mattress sutures of no. 30 or 40 cotton or with a running, interlocked suture similar to the one made with the Singer machine. There is practically no difference in time required to place either of these; however, the running suture, so made, has the additional advantage that it may be removed completely merely by cutting off the knot at both ends, and with one pull the entire suture line is removed.

The majority of the wounds repaired with cotton sutures in this series were drained. Scrotal wounds were drained for from one to four days, the average being two days, with small strips of rubber dam drain. In cases of renal and ureteral operation the wounds were drained four days with a large strip of rubber dam drain. Since in cotton there is no loss in tensile strength for ten days, and then only a slight loss in the following days, these patients may be allowed out of bed just as soon as their general condition permits. Patients who have undergone scrotal operations sometimes are up walking around on the first postoperative day. If the general condition permits in the other cases the patient is permitted to sit up in bed on the first two postoperative days, is out of bed in a chair on the third postoperative day and walks about with help on the fourth postoperative day.

There were no chronic sinuses, no extrusion of knots or sutures, no induration and no wound disruptions or postoperative hernias. The rapidity of healing, the lack of drainage and absence of infection are remarkable. Healing is rapid, clean and certain.